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Vol. IV Assessment of Methods of Acquiring, Analyzing, and Reporting Crop Production Statistics

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16 Abstract The purpose of this study was to describe and document in as much detail as possible the current methodologies for obtaining, analyzing, and reporting wheat production statistics in Argentina, Canada, India, the Soviet Union and the United States. Where sufficient documentation was available statistical estimation procedures were compared to determine methods for improving wheat production estimates. The study documented the lack of standardization between major wheat producing countries in their methods of collecting crop statistics, in kinds of statistical data collected, in the methods of analysis and interpretation of data, and in the final reporting and utilization of data. One interesting aspect is the differences between countries in the basic reasons for obtaining crop statistics. Results of the study should provide documentation to support the need for standardization and improvement in the reporting of national and global crop production statistics.					
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CHAPTER 1

SUMMARY

The objective of this study was to describe and document the current methodologies for obtaining, analyzing and reporting crop production statistics in Argentina, Canada, India, the Soviet Union and the United States. Each country uses the same general methodology for each of the major crops within that country. Although this project considered crop statistics in general, major attention was given to wheat statistics methodologies.

Of the five major wheat-producing countries examined, most wheat area estimates are made by subjective or nonprobability methods (Figure 1.1). The United States relies substantially on area frame sampling. Objective methods for determining areas in wheat are used in the other countries to a very limited degree.

Country	Subjective Methods	Objective Methods
Argentina	Inspectors (Interviews with farmers)	Very limited use (Buenos Aires Province only)
Canada	Mail surveys Agricultural census - enumeration every 10 years	Agriculture Enumerative Survey (experimental) Farm Expenditure Survey (initiated in 1977 in prairie provinces)
India	Land revenue officers total enumeration	Investigators (limited area)
Soviet Union	Total enumeration on state and collective farms (97%)	Sample surveys on private lands (3%)
United States	Mail surveys	Trained enumerators (area frame sampling)

Figure 1.1 Summary of methods used to estimate wheat areas

Wheat yield estimates are not readily available on a regular basis to the public in most of the major wheat-producing countries. Where yield estimates are reported, most statistics are derived from subjective methods (Figure 1.2). Of the five countries examined, the United States relies most on objective yield surveys, and India uses crop cutting surveys.

Country	Subjective Methods	Objective Methods
Argentina	<ul style="list-style-type: none"> - Biweekly reports of inspectors - Interviews with farmers, grain merchants, harvest crews 	None
Canada	<ul style="list-style-type: none"> - Mail surveys 	None
India	<ul style="list-style-type: none"> - None 	Investigators (Crop cutting surveys)
Soviet Union	<ul style="list-style-type: none"> - No official forecast made 	None
United States	<ul style="list-style-type: none"> - Mail surveys 	Trained enumerators (Objective yield surveys)

Figure 1.2 Summary of methods used to estimate wheat yields.

The reporting of wheat statistics varies significantly among the five countries studied. In general, the public reporting on a regular basis of wheat area, predicted yields and production is extremely limited (Figure 1.3). The two extremes are represented by the Soviet Union and the United States. The Soviet Union regularly reports to the public the area planted in wheat as the growing season progresses. However, the only public reporting of yield and production is released as historical data many months after harvest has been completed. The United States issues on a regular basis throughout the growing season public reports on area estimates and predicted yields and production.

Country	Month											
	J	F	M	A	M	J	J	A	S	O	N	D
Argentina												
Area						x	x		x			
Yield	x		x									x
Production	x		x									x
Canada												
Area	x			x		x		x				x
Yield	x								x	x	x	
Production	x								x	x	x	
India												
Area			x	x							x	
Yield			x	x								
Production												
Soviet Union												
Area				x	x	x	x	x	x	x	x	
Yield												
Production												
United States												
Area	x					x	x	x	x	x	x	x
Yield						x	x	x	x	x	x	x
Production						x	x	x	x	x	x	x

Figure 1.3 Comparison of schedules for reporting wheat statistics by Argentina, Canada, India, USSR and USA.

In order to formulate meaningful summary statements resulting from this study, the authors felt the need to express two assumptions:

- More accurate, timely statistics on current and predicted world wheat area, yield and production will be beneficial to society through
 - stabilization of prices
 - more effective production planning
 - more effective distribution.
- Current and projected advances in data acquisition, data analysis and information dissemination technology suggest that a significant improvement can be made during the next decade in a global information system for wheat.

With these assumptions in mind, the following summary statements of weaknesses of the present methodologies suggest the critical need for and feasibility of an improved global information system for wheat:

1. There is no standardized, global system for acquiring, analyzing and reporting wheat production statistics.
2. Among the major wheat-producing countries there is no common rationale for reporting wheat production statistics publicly.
3. Under current methods of reporting, it is not possible to determine quantitatively the statistical reliability of the global estimates of wheat area, yield and production.
4. Current methods of making wheat production estimates in several major wheat-producing countries are subject to gross error.
5. The U.S. Department of Agriculture relies substantially on objective yield data to predict wheat production at the state level; to predict national production, subjective adjustments are made in the data prior to release of the periodic crop reports.

CHAPTER 2

PROJECT DESCRIPTION AND APPROACH

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CHAPTER 2

PROJECT DESCRIPTION AND APPROACH

2.1 Rationale

From a global perspective the past decade has been punctuated by drought, flooding, environmental deterioration, land degradation, and famine. As the human demands for food and fiber increase, improved management and conservation of world agricultural resources become imperative. One of the requirements for improving the management and conservation of agricultural resources is more complete information about these resources--soil productivity, cultivated areas, crop yields and production, water resources, meteorological data, beneficial and detrimental changes in these resources.

The growing economic interdependence among countries further emphasizes the need for an improved global information system for food and fiber. Since World War II international trade has expanded more rapidly than world gross output, with the results that individual countries have tended to become increasingly dependent on foreign trade both for markets and as a source of supply for important raw materials and other goods and services.

Many studies within the past five years have addressed the problem of providing more accurate, timely, useful, inexpensive information to the decision-maker throughout the food production and delivery chain. One of the factors inhibiting agricultural development in the world is the dearth of timely, useful information necessary for rational planning, development and management of the various resources related to agricultural production and food distribution.

2.1.1 Importance of Information for Development. The importance of information in the development and management of resources is seldom given sufficient emphasis. Information is a valuable commodity, an essential in resource development. One of the oft overlooked features of efficient food production is the supporting information system. As the demands increase for greater and more efficient production of food from a nation's agriculture, the role of information in food production becomes more critical. It becomes more important that accurate, useful, inexpensive and timely information be available to the producer, marketer, processor and distributor of food. In a sense, the efficiency of a nation's agriculture may be related to the quality and quantity of information available to decision-makers and policy-makers. This holds true in the development of other resources as well.

An important characteristic of a highly productive agriculture is the emphasis placed on the collection and analysis of useful data and the dissemination and utilization of information. Today in many countries

government agencies, industries, and individual farmers or producers subscribe to information services which may provide useful information for making sound agricultural production and marketing decisions. On the other hand; areas of inefficient food production may be characterized by the unavailability of information necessary to make rational decisions.

2.1.2 Significant Advances in Information Technology. The past three decades have brought significant changes in several areas of technology which have substantially improved our way of observing, perhaps even conceiving, the resources we have at our disposal for the production of food. One of the areas of technology that has changed significantly is the area of data acquisition, new instruments for observing our environment from the interior of the atom to a synoptic view of the earth surface from hundreds or thousands of kilometers above the earth. During this period in which these instruments have been developed, the electronic computer has emerged. It is now possible to store, retrieve and analyze masses of data unimaginable even a few years ago.

In this same time frame the science of communication has made great advances. It is now possible to transmit from one point on the earth surface to any other point images, voices, or masses of data instantaneously. The combined use of these areas of technology to survey and monitor earth surface features has brought a new era to earth observations. We can now obtain vital information about land, mineral, vegetation, and water resources quickly and repetitively. In many cases we can obtain data that are available to us from no other source.

In fact, we represent the first generation who can literally see the Earth as a whole. What we have seen before were only little bits and pieces, and we would take the little bits and pieces and hang them together in maps which, in a sense, were an attempt to construct a picture of the Earth as it would be seen from space. We then progressed through aerial surveillance in which we could cover larger areas where less piecing together was required. It was not until we ventured into space that we reversed our concepts of looking at the Earth. Now we can begin with the broad synoptic view from which we may then extract the details. In a sense, we have turned the whole enterprise around. Instead of starting with the details and trying to construct the big picture, we now have the capability to begin with the big picture and proceed to extract the details that explain it.

2.1.3 Critical Need for Efficient Information Systems. In 1981 the launch of Landsat-D will introduce a new family of data-collection sensors. It will provide great improvements over the present satellite sensors. One of the difficulties of preparing for the use of this technology by developing countries is that the present research and development program is driven by the resource and political constraints of U.S. government agencies. Relatively little attention has been focused on the needs of the developing world. There is critical need for research and development to be directed toward a strategy for implementation of effective resource information systems which are feasible and workable in all countries, developed and developing.

In the design and planning of improved information systems for agriculture it is important to examine carefully the existing information systems, to assess their utility and efficiency, and to weigh the need for improvement or change. This study was designed to examine the current wheat information systems in five of the major wheat producing countries of the world--Argentina, Canada, India, the Soviet Union and the United States. By an examination of current information systems it is hoped that feasible and workable ideas for improvements may emerge.

2.2 Objectives

The primary objective of the study was to describe and document in as much detail as possible the current methodologies for obtaining, analyzing and reporting wheat production statistics in Argentina, Canada, India, the Soviet Union and the United States. Where sufficient documentation was available statistical estimation procedures were compared to determine methods for improving wheat production estimates.

A secondary objective was to work cooperatively with Mr. Osvaldo Stepancich, head of the Statistical Estimates Section, National Service of Economics and Rural Sociology, Argentine Secretariat of Agriculture and Livestock. This cooperative study involved the detailed comparison and evaluation of several existing procedures for obtaining, analyzing and reporting wheat production statistics in Argentina.

2.3 Approach

The study was implemented in four steps:

- literature search;
- contacts with wheat statistics specialists for each of the countries under study;
- description of methodologies used in each country for acquiring, analyzing and reporting wheat production estimates; and
- comparison of estimation procedures used in the five countries included in this study.

2.3.1 Literature search. The literature search was conducted primarily within the Purdue University Library system and the National Agricultural Library of the U.S. Department of Agriculture. Publications of the following agencies were reviewed and found to be most useful in this study:

General

- a. International Food Policy Research Institute, Washington D.C.
- b. International Wheat Council, London
- c. United Nations

Department of Economic and Social Affairs, New York
Food and Agriculture Organization, Rome

d. United States Department of Agriculture

Economic Research Service, Washington D.C.
Foreign Agricultural Service, Washington D.C.

Argentina

a. Secretaria de Estado de Agricultura y Ganaderia

Servicio Nacional de Economia y Sociologia
Rural, Buenos Aires

b. U. S. Department of Agriculture

Foreign Agricultural Service, Washington D.C.

Canada

a. Canadian Grain Commission, Ottawa

b. Statistics Canada, Ottawa

India

a. Indian Council of Agricultural Research, New Delhi

b. Indian Ministry of Agriculture and Irrigation

Directorate of Economics and Statistics, New Delhi

c. Indian Society of Agricultural Statistics, New Delhi

d. U. S. Department of Agriculture

Foreign Agricultural Service, Washington D.C.

Soviet Union

a. Central Intelligence Agency (United States)

Office of Economic Research, Washington D.C.

b. U. S. Department of Agriculture

Foreign Agricultural Service, Washington D.C.

United States

a. U. S. Department of Agriculture, Washington D.C.

Agricultural Stabilization and Conservation Service
Economic Research Service
Statistical Research Service

2.3.2 Contacts with Wheat Statistics Specialists. Contacts were established by correspondence with specialists in wheat production statistics for each of the countries under study. These contacts included specialists in the Argentine Secretariat of Agriculture and Livestock, Agriculture Canada, the Indian Ministry of Agriculture and Irrigation, the U. S. Department of Agriculture, the United Nations and the International Food Policy Research Institute. Unfortunately, there was no personal contact with wheat production statistics specialists in the Soviet Union. Information about the Soviet Union was obtained from specialists on the Soviet Union in the U. S. Department of Agriculture, the United Nations, and the Office of Economic Research of the Central Intelligence Agency.

The purpose and scope of the study was explained to each of the cooperating specialists. Specialists for each country were then requested to assist in describing and documenting the methods used in each country for obtaining, analyzing and reporting wheat production statistics.

2.3.3 Description of Methodologies. From the beginning of the study it was recognized that the methods used in the five countries under study were very different. One of the initial tasks was to design a systematic approach to describe and document the methods used by the different countries.

In the literature and in interviews with specialists certain basic information was sought:

a. Methods of data collection

- sample design
- kind of data collected
- procedure for collecting data
- specific questions

How are area and yield measurements made?

At what times during the growing season are yield estimates made?

What statistical method is used for aggregating estimates?

b. Methods of data analysis

- forecasting and estimation (e.g., ratio, regression) procedures
- precision of estimates
- specific questions

Are area measurements used in estimating yield?

How are yield measurements used in estimating wheat production?

At what level are estimates made--county, district, state, national?

c. Methods of reporting

- percent of error reported at district, state, national levels
- adjustment for bias
- aggregation
- schedule of reporting
- distribution of reports

2.3.4 Comparison of Estimation Procedures. The study team set out to attempt a comparison among the methodologies of the five countries. Ideally, the following factors would have been examined and documented in the comparison:

- data collection methods
- data analysis methods
- economic indications
- adaptability
- precision
- cost

It was not possible to make these comparisons to the extent desirable. The major reason was that the methodologies were so different that the comparisons of some factors was not valid. Another reason was lack of quantitative data on which to base comparisons. However, general comparisons of objectives, overall methodologies, effectiveness in meeting objectives, and needs for improved information systems for wheat production statistics were addressed.

2.4 Comments

A section for comments is included at the end of each of the chapters which follow. In this chapter an overview of the study is provided, and a comparison or assessment of methodologies is not appropriate.

The limited scope of this study did not permit the examination of the costs of alternative methods of collecting, analyzing and reporting crop production statistics. However, the study did reveal that the cost of training enumerators and operating a crop survey program is an important limiting factor in the development of improved agricultural information systems.

In general, the funds required to implement and operate a comprehensive crop survey program each year by the various countries are considerably greater than is presently spent on crop surveys. Perhaps a high priority should be assigned to the task of studying the cost-benefit ratio for implementing improved crop estimates and timely reports.

All publications of the U.S. Department of Agriculture used in this study predate the reorganization and agency name-changes made under the current administration. Pre-reorganization terminology is used in the text to refer to specific agencies of USDA.

CHAPTER 3

WHEAT STATISTICS METHODOLOGY IN ARGENTINA

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CHAPTER 3

WHEAT STATISTICS METHODOLOGY IN ARGENTINA

3.1 Agricultural Statistics in Argentina3.1.1 Organization and Responsibilities of Statistical Agencies.

There are three branches responsible for agricultural statistics within the Agriculture and Livestock Secretariat in Argentina. These three are the Methodology, Crop Statistics and Livestock Statistics Sections under the administration of the National Department of Economics and Rural Sociology (1).

The Crops Statistics Section makes the final recommendations concerning area and production statistics to the Subsecretary of Agricultural Economics who issues the national crop reports. The present Methodology Section has operated for ten years and is responsible for establishing sample surveys in several provinces to estimate livestock numbers and production. Provincial inspectors are employed by the Secretary of the Interior, but their reports are sent to the Crop Statistics Section.

3.1.2 Current Methods of Collecting Crop Statistics. The current federal system of acquiring agricultural statistics consists of traditional subjective methods combined with limited use of area probability surveys. These traditional methods rely to a great extent on the reports of 43 federal inspectors assigned to the 22 provinces in Argentina with nearly half of the inspectors concentrated in the high density wheat area (Figure 3.1). In Buenos Aires Province there are 22 inspectors alone. The major wheat growing region in Argentina may be subdivided according to season, growing conditions and varieties (Figure 3.2). Statistics related to growing season, area, yield and production have been compiled for each of the wheat regions (Table 3.1). There are significant differences among regions in the soils, climate and other growing conditions.

Crop data are collected by an inspector from farmers within his assigned region. Inspectors submit their reports to the Department of Estimation twice a month. These reports include statistics on harvested areas, precipitation and temperature data, and comments on growing conditions and crop status. Other sources of information obtained by the inspectors include bankers, officials of cooperatives, seed merchants, agricultural chemical dealers and others.

Agricultural census data are also used as a basis for crop statistics. Since 1888 eleven censuses have been conducted in Argentina, the two most recent in 1969 and 1974. Results are usually published two years following data collection. Overall, except for the provinces of Buenos Aires and Santa Fe, base maps for census operations are inadequate and may result in overlapping census districts within departments of each province.

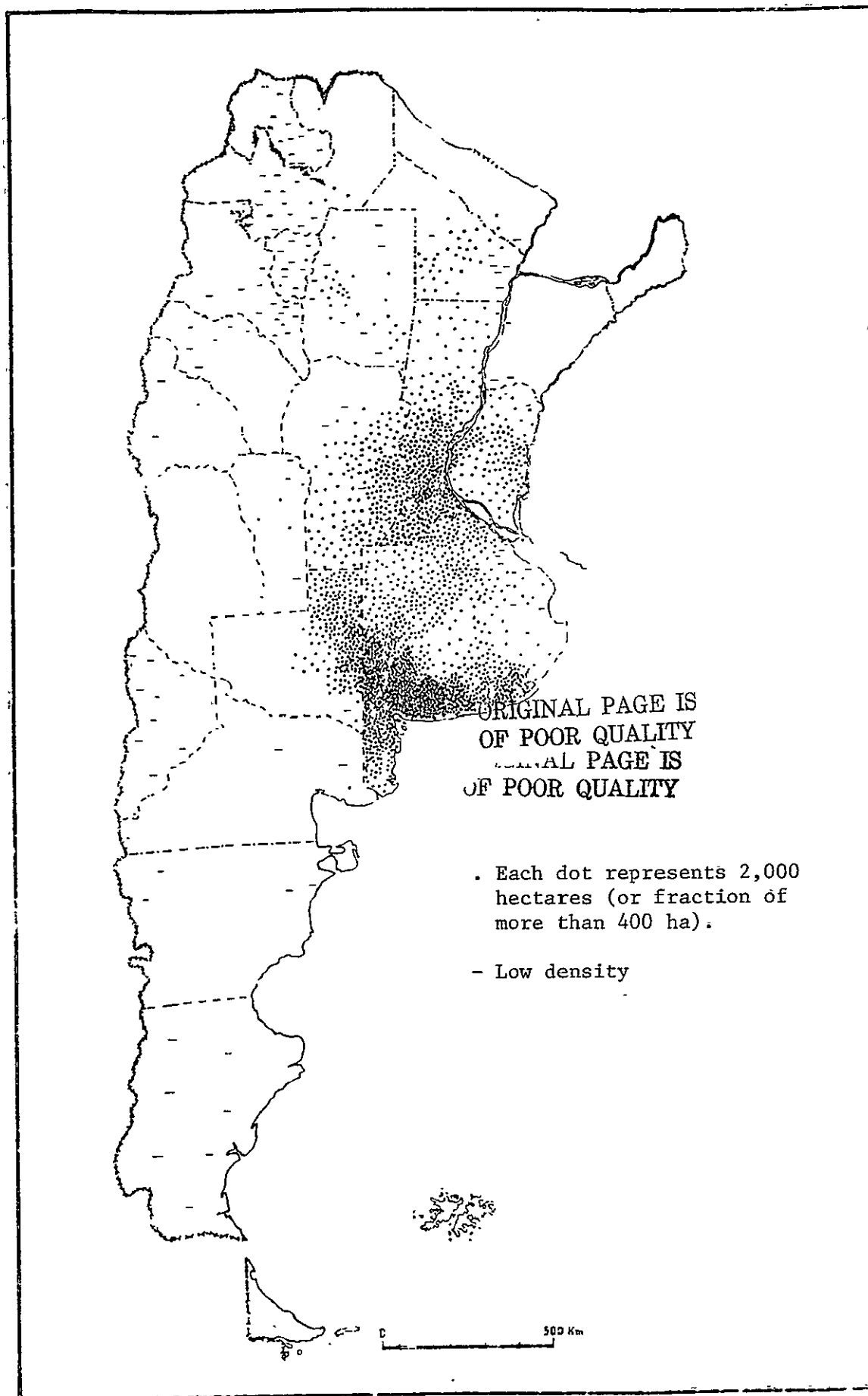


Figure 3.1 Density of area sown to wheat in Argentina, 1971-72 (2).
(Total area in wheat: 4,986,000 ha)

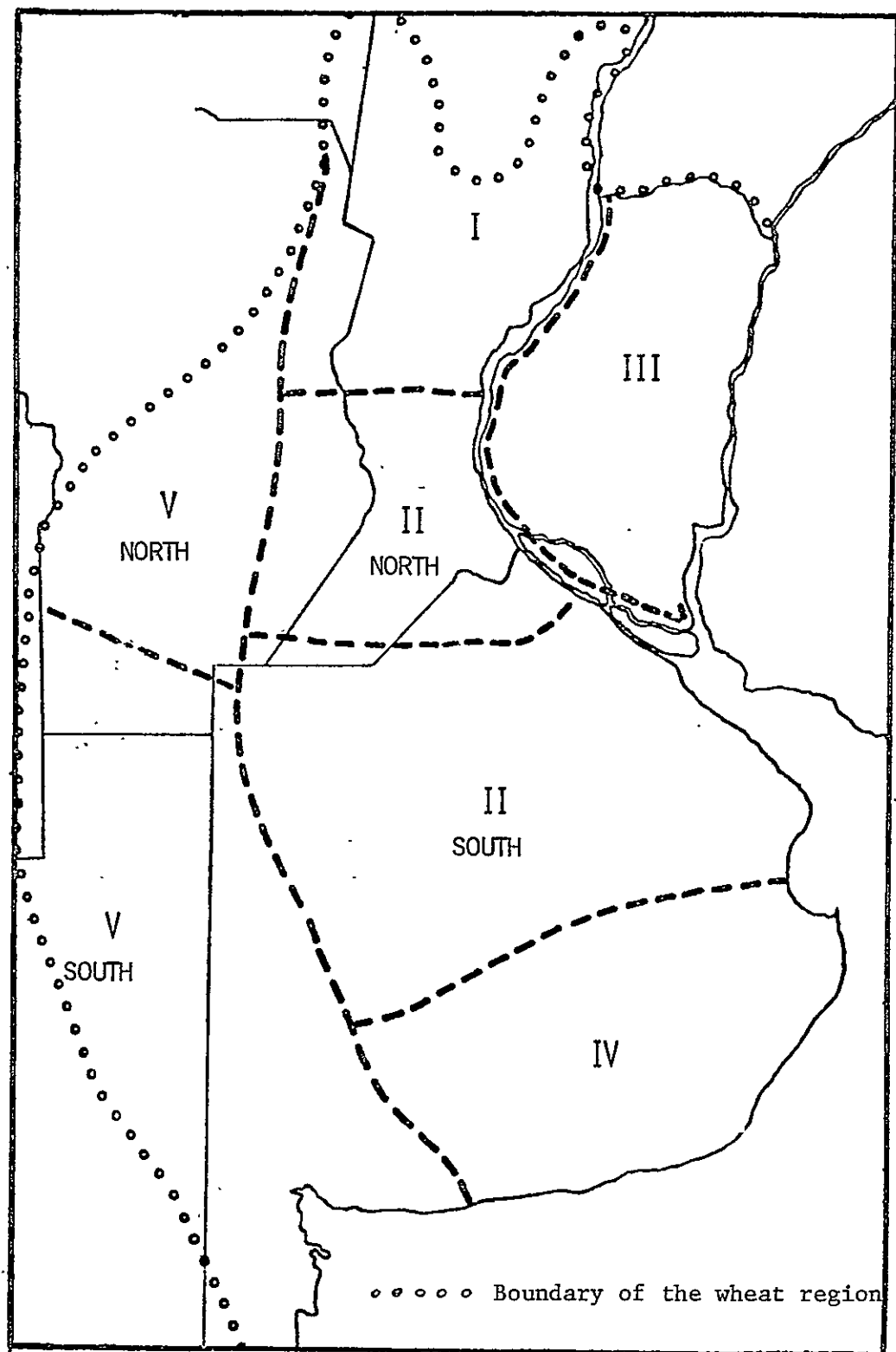


Figure 3.2 Subdivisions within the major wheat-growing region of Argentina (4).

Table 3.1 Wheat regions of Argentina (4).

Region	I	IIN*	IIS*	III	IV	VN*	VS*
Stages of Growth							
Planted	May-Jun	Jun-mid Jul	end May/ mid Jul	mid May/ mid Jul	end May/ mid Jul	May-Jun	mid May/ mid Jul
Booted	1-20 Sep	early Oct	20 Oct	20 Oct	10 Nov	10 Oct	mid Oct/ early Nov
Ripened	Oct	10-20 Nov	end Nov	end Nov	10 Dec	10-20 Nov	20 Nov/ mid Dec
Harvested	early Nov	end Nov/ first Dec	10-20 Dec	10-20 Dec	end Dec/ early Jan	end Nov/ first Dec	early Jan
Area	6.3%	15.5%	15.0%	5.5%	13.9%	5.0%	38.8%
Yield (kg/ha)	1500	2000	1700	1500	1800	1300	1400
Production	4.5%	17.7%	17.5%	4.0%	17.2%	2.7%	36.4%

*N = North

*S = South

3.1.3 Probability Sampling in Buenos Aires Province. In 1972 the province of Buenos Aires was stratified and sample units were selected following a two stage sampling scheme. The purpose of this stratification was to obtain improved livestock estimates and enumerate cultivated areas in wheat, grain sorghum, flax and corn within sample units. Sample surveys based upon this stratification were conducted in 1972, 1973 and 1976.

In Buenos Aires Province there are about 120,000 farms covering an area of approximately 30 million hectares. Of these, 3,150 farms (7.9% of the total land area) were surveyed. The list frame used to identify farms within sample units was obtained from the 1969 agriculture census.

a. *Stratification.* Census districts (similar to townships in the U.S.) were defined as the primary units within a stratum. There are an average of 15 census districts in each department (similar to a county in the U.S.), and Buenos Aires Province contains 120 departments. The greater metropolitan area of the city of Buenos Aires covers twenty of these departments. These were excluded from the survey. The Province was stratified geographically (Figure 3.3) according to the predominant agricultural characteristic (Table 3.2).

Table 3.2 Predominant agricultural characteristics in strata of Buenos Aires Province (3).

<u>Stratum</u>	<u>Characteristic</u>
I	livestock, mixed
II	cattle
III	corn
IV	grain sorghum
V	sunflower
VI	flax
VII	wheat

b. *Sampling plan.* One hundred fifty farms were selected with probability equal to 1.0. These farms accounted for five percent of the cultivated land in the Province of Buenos Aires. The remaining 3000 farms were selected according to a probability plan described below. Within each stratum census districts were the primary units. Two segments (the secondary units) were selected within the primary units and were defined such that there was an average of five farms per segment. Thus, 300 primary units were selected for a total of 3000 farms. For each stratum there was a constant overall sampling fraction for each selected segment.

Primary units were selected with unequal probabilities to reduce variance. To determine the probability of selection for these units, data from the 1969 Agricultural Census and 16 different linear combinations (Table 3.3) of probabilities for each agricultural characteristic (including number of cattle and sheep, areas of corn, wheat and sunflowers) were considered for each stratum. For each stratum each pertinent probability combination was examined to determine the number of primary units required for a specified

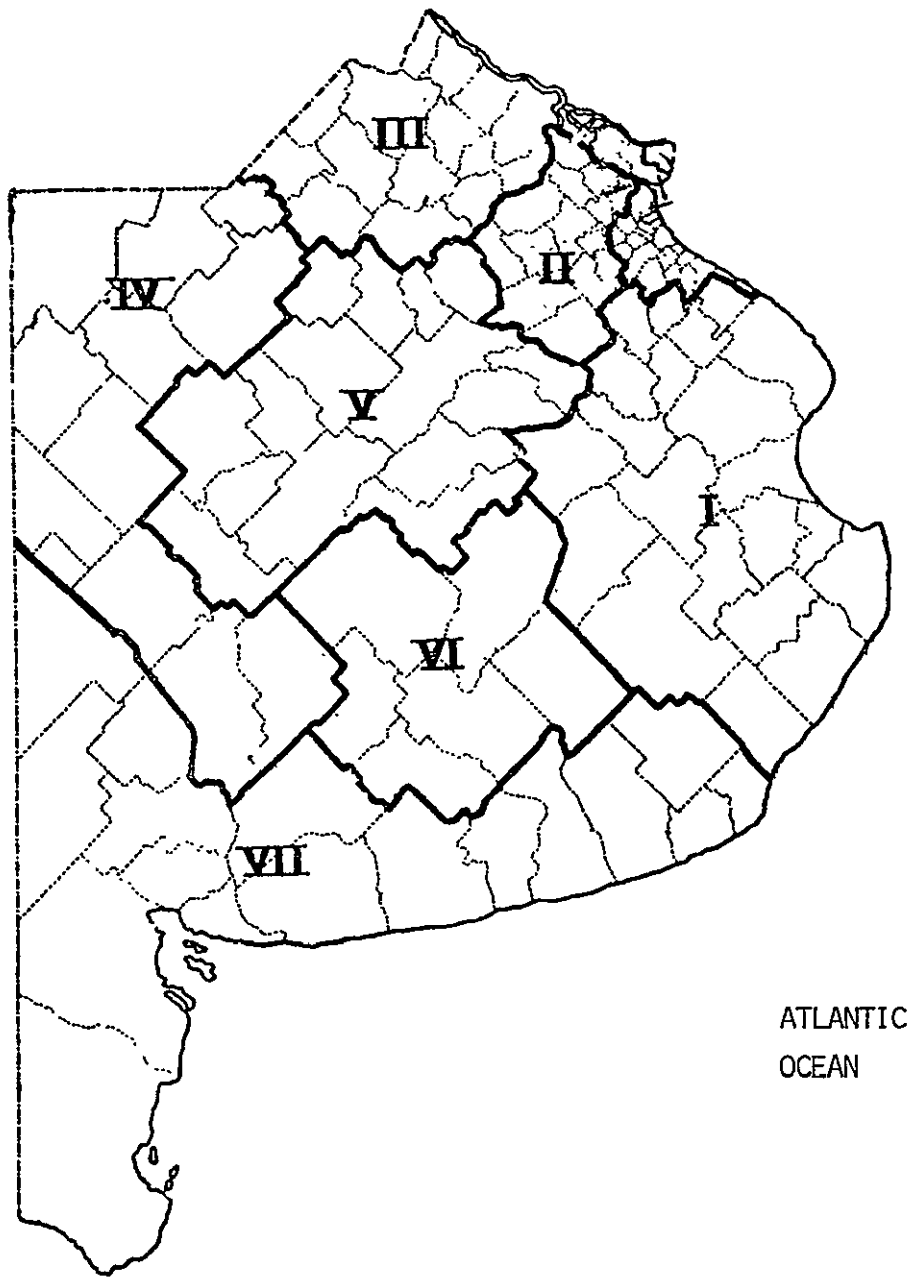


Figure 3.3 Boundaries of strata in the Province of Buenos Aires (3).

Table 3.3 Sixteen probability combinations considered (3).

$$P_1 = \frac{P(\text{cattle}) + P(\text{sheep})}{2}$$

$$P_2 = \frac{P(\text{cattle}) + P(\text{sheep}) + P(\text{wheat})}{3}$$

$$P_3 = \frac{P(\text{cattle}) + P(\text{wheat})}{2}$$

$$P_4 = \frac{P(\text{cattle}) + P(\text{wheat}) + P(\text{cultivated land})}{3}$$

$$P_5 = \frac{P(\text{cattle}) + P(\text{cultivated land})}{2}$$

$$P_6 = \frac{P(\text{cattle}) + 2*P(\text{cultivated land})}{3}$$

$$P_7 = \frac{2*P(\text{cattle}) + P(\text{corn}) + P(\text{cultivated land})}{4}$$

$$P_8 = \frac{P(\text{cattle}) + P(\text{corn}) + P(\text{cultivated land})}{3}$$

$$P_9 = \frac{P(\text{cattle}) + P(\text{sunflower})}{2}$$

$$P_{10} = \frac{P(\text{cattle}) + P(\text{sunflower}) + P(\text{cultivated land})}{3}$$

$$P_{11} = \frac{2*P(\text{cattle}) + P(\text{cultivated land})}{3}$$

$$P_{12} = \frac{P(\text{cattle}) + P(\text{cultivated land}) + P(\text{sheep})}{3}$$

$$P_{13} = \frac{P(\text{cattle}) + P(\text{sunflower}) + P(\text{corn}) + P(\text{wheat})}{4}$$

$$P_{14} = \frac{2*P(\text{cattle}) + P(\text{sunflower}) + P(\text{corn}) + P(\text{wheat})}{5}$$

$$P_{15} = \frac{P(\text{cattle}) + P(\text{cultivated land}) + P(\text{sunflower}) + P(\text{corn}) + P(\text{wheat})}{5}$$

$$P_{16} = \frac{P(\text{cattle}) + 2*P(\text{cultivated land}) + P(\text{sheep})}{4}$$

coefficient of variation. Results of each probability combination were evaluated for each stratum using a minimum variance criterion, and probability combinations were selected for each stratum (Table 3.4).

Secondary units, segments, were selected so as to have a constant sampling fraction within the stratum. For example, if f_{h1} is the sampling fraction for the primary units, then f_{h2} is chosen such that $f_{h1} \times f_{h2} = f_h$, the sampling fraction for h .

c. *Allocation.* Since only 300 primary units were to be selected, a study was conducted to compare an optimal allocation procedure with allocation based on a coefficient of variation of 10%. Prior measure of variation was available from the 1969 census. Results of both allocation procedures were compared for each stratum and variable (both livestock and crops) to be estimated. The allocation of sample units was then determined in a subjective manner such that the total number of primary units would be 300.

d. *Estimation and results.* Both direct expansion and ratio estimates were calculated for bread wheat and macaroni wheat (Table 3.5). Note that there is a complete enumeration of 150 which account for 5% of the cultivated area in Buenos Aires Province and that this enumerated figure is added to the estimated value.

This survey was originally designed for the purpose of obtaining livestock estimates. Less attention was given to methods of collecting crop statistics. Lack of field supervision of enumerators and bias introduced by reports from individual farmers of planting intentions rather than actual planted areas resulted in inaccurate estimates for crops. In addition, the survey was conducted at a time which was optimal for enumerating cattle but not necessarily for all crops.

3.2 Area Estimates

The previous section has described two different procedures for estimating crop areas in Argentina--the traditional inspector method and the probability sampling method. In all except strata II and VII the area estimates by inspectors are considerably lower than the estimates by probability sampling, the differences ranging from approximately 20% to 38% (Table 3.6). For stratum II the inspector area estimate was approximately 20% higher than the probability sampling estimates; for stratum VII the inspector estimate was 35% higher than the probability sampling estimates. Since more than 40% of the area planted to wheat in Buenos Aires Province is in this stratum, this discrepancy poses serious questions.

Although probability surveys have been used to estimate the wheat areas in Buenos Aires Province, the use of this method of surveying has not been accepted for determining the national area estimates.

3.3 Yield Estimates

Argentina does not employ objective methods for determining yield estimates. National estimates are based on the biweekly reports of the

Table 3.4 Selected probability combination for each stratum (3).

<u>Stratum</u>	<u>Selected Probabilities</u>
I - (cattle & sheep)	$P_1 = \frac{P(\text{cattle}) + P(\text{sheep})}{2}$
II - (cattle)	$P_5 = \frac{P(\text{cattle}) + P(\text{cultivated crops})}{2}$
III - (corn)	$P_8 = \frac{P(\text{cattle}) + P(\text{cultivated crops}) + P(\text{corn})}{3}$
IV - (grain sorghum)	$P_{16} = \frac{P(\text{cattle}) + 2*P(\text{cultivated crops}) + P(\text{sheep})}{4}$
V - (sunflower)	$P_{10} = \frac{P(\text{cattle}) + P(\text{sunflower}) + P(\text{cultivated crops})}{3}$
VI - (flax)	$P_{12} = \frac{P(\text{cattle}) + P(\text{cultivated crops}) + P(\text{sheep})}{3}$
VII - (wheat)	$P_2 = \frac{P(\text{cattle}) + P(\text{sheep}) + P(\text{wheat})}{3}$

Table 3.5 1976 estimate of hectares planted in wheat in Buenos Aires Province (3).

Estimator	Bread Wheat		Macaroni Wheat	
	Estimation and Estimated Standard Error	Estimation of the Coefficient of Variation	Estimation and Estimated Standard Error	Estimation of the Coefficient of Variation
$X'_T = \bar{X}_{IF} + \sum_{h=1}^{VII} x'_h \cdot \frac{1}{f_h}$	$X'_T = 3,128,360$ $\hat{\sigma}_{x'_T} = 148,374$	$\hat{CV}_{x'_T} = 4.68\%$	$X'_T = 305,854$ $\hat{\sigma}_{x'_T} = 64,012$	$\hat{CV}_{x'_T} = 16.25\%$
$X'''_T = \bar{X}_{IF} + \sum_{h=1}^{VII} \frac{x'_h}{y'_h} \cdot Y_h$	$X'''_T = 3,426,204$ $\hat{\sigma}_{x'''_T} = 204,560$	$\hat{CV}_{x'''_T} = 5.97\%$	$X'''_T = 307,997$ $\hat{\sigma}_{x'''_T} = 68,115$	$\hat{CV}_{x'''_T} = 22.12\%$

Notation:

X'_T = direct expansion estimate of total area planted

X'''_T = ratio estimate of total area planted

\bar{X}_{IF} = total area planted on farms selected with probability = 1

x_h = area planted in stratum h

$x'_h = x_h \cdot \frac{1}{f_h}$

f_h = sampling fraction for stratum-h

Y_h = actual area in stratum h

$y'_h = y_h \cdot \frac{1}{f_h}$ = estimated area in stratum h

y_h = total area sampled in stratum h

Table 3.6 Sampling and inspector estimates for wheat areas in Buenos Aires Province.*

Stratum	Estimate	Bread Wheat (hectares)	Macaroni Wheat. (hectares)
I	Probability Sample		
	Direct Expansion	73,988	8,974
	Ratio	73,999	8,975
	Inspector	59,010	7,800
II	Probability Sample		
	Direct Expansion	23,182	5,510
	Ratio	23,989	5,703
	Inspector	29,400	-
III	Probability Sample		
	Direct Expansion	349,314	2,025
	Ratio	364,774	2,116
	Inspector	224,400	-
IV	Probability Sample		
	Direct Expansion	782,997	4,649
	Ratio	793,177	4,716
	Inspector	618,000	-
V	Probability Sample		
	Direct Expansion	548,119	1,420
	Ratio	545,945	1,414
	Inspector	372,500	-
VI	Probability Sample		
	Direct Expansion	317,202	31,956
	Ratio	301,694	30,349
	Inspector	245,300	46,700
VII	Probability Sample		
	Direct Expansion	1,300,904	251,320
	Ratio	1,303,357	251,793
	Inspector	2,005,000	275,500
TOTAL	Probability Sample		
	Direct Expansion	3,395,706	305,854
	Ratio	3,406,935	305,066
	Inspector	3,553,610	330,000

*Personal communication with Mr. Osvaldo Stepancich.

inspectors. In addition to interviewing farmers and grain merchants in their districts, inspectors obtain information from harvest equipment operators for current harvest conditions and expected yields.

3.4 Crop Reports

All official crop reports are based on subjective estimates of area planted, crop conditions and expected yield by federal inspectors. A forecast of area to be planted in wheat is issued in June. This report is based on planting intentions. Other estimates of area planted in wheat are reported in July and September. Production and derived yield estimates are reported in December, January and March. In Argentina the wheat harvest is generally completed by mid-February.

3.5 Comments

Lack of trained field personnel and operational funds have greatly limited the development of a comprehensive crop survey program in Argentina. This may account, at least in part, for the increasing interest in that country to use satellite scanner data for making crop estimates. The idea is attractive in a country where the fields are generally large (50 hectares and larger) and the agricultural scene is relatively simple. That is, only a few crops are grown commercially over large areas.

Although the use of remote sensing technology seems to have great merit for conducting crop surveys in Argentina, it is important that a sound probability sampling procedure be designed and implemented so that survey techniques using satellite data can be statistically evaluated. Reflectance data from satellite scanners contains valuable information about the agricultural scene, but interpretation of the data for crop estimation purposes may be seriously questioned if there is no scientific ground sampling method to corroborate the results.

3.6 Literature Cited

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CHAPTER 4

WHEAT STATISTICS METHODOLOGY IN CANADA

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CHAPTER 4

WHEAT STATISTICS METHODOLOGY IN CANADA

4.1 Agricultural Statistics in Canada

Statistics Canada has the primary responsibility for all collection, analysis and reporting of agricultural statistics (1). These activities are carried out by the Agriculture Division with some assistance from the provincial departments of agriculture. Reports are based essentially on the results of periodic mail questionnaires in addition to probability surveys and the use of benchmark data. Recent additions to the general statistical process have been an enumerative survey for area statistics and some harvest experiments for fruits and vegetables.

In general, the crop reporting system is characterized by coordination and cooperation between the various agencies within Statistics Canada which include the census, methodology and data processing section, the crop reporting unit and commodity analysts. The system is self-correcting in that benchmark data are periodically evaluated and updated as warranted.

4.2 Area Estimation

Area forecasts and estimates are determined by updating benchmark data with the use of results from mail and enumerative surveys. The benchmark data are obtained from the agricultural census which is conducted every five years. In this section, descriptions of the agricultural census methodology, the sampling scheme for the enumerative surveys and illustration of mail questionnaires and procedures are given.

4.2.1 Agricultural Census. The main source of benchmark data for statistical purposes is the quinquennial agricultural census last conducted in 1976 by Statistics Canada. This census is taken every five years for the purpose of obtaining data on individual landholdings to be used as a benchmark for forecasts and estimates (2).

Every tenth year the census is distributed in connection with the population census. Census forms are then collected three days later by the enumerators. Responding is encouraged by guaranteed confidentiality and prosecution of non-respondents. A fairly complete list frame can be compiled from the census as a result and used for other surveys and the next census.

All land must be accounted for by the enumerator; this includes both range and crop land. For the prairie provinces, very good grid maps are available which facilitate the accounting procedure.

Information is obtained for all agricultural holdings larger than one acre and with annual sales greater than \$50. Census-farms are defined as holdings with more than \$1200 in earnings and are considered the basic reporting units for all census data.

Seventy-seven items were included in the questionnaire for the 1976 Census of Agriculture (Figure 4.1). Census information is collected on farm land which is classified according to land use: improved land and unimproved land. Improved land includes all crop land, summer fallow (item 38 of census), cultivated pasture (item 37) and other improved land areas (item 39). Woodland (item 40) and uncultivated natural vegetation (item 41) make up the unimproved land. Thus, basic data are provided for subsequent stratification by land use.

The census obtains much socio-economic data which is used in federal income stabilization plans. These data include the capital values of land (item 5) and farm equipment (item 71) and amount of farm labor required (item 72).

In the quinquennial census for 1976, acreage information is requested for the total farm operation (item 3) and is then tabulated by use (items 6-41). Additional information which is collected in the decennial census includes data on irrigation and fertilization.

Ten months are required for compilation of final results of the census. Of the 330,000 agricultural holdings, data for 300,000 census-farms are reported.

4.2.2 Agriculture Enumerative Survey. In 1971 the Agricultural Enumerative Survey (AES) was introduced as a quality check on the census and has been continued annually on an experimental basis. In 1974 the survey was redesigned and run in parallel with the crop reporting system. This enumerative survey is a multipurpose survey covering the categories of area, land use, livestock and poultry, total value of agricultural sales and farm operation expenses and credit received. This survey was designed to provide an accurate accounting of agricultural commodities.

a. Sampling plan. A two-stage stratified design is used to select the sample. First, enumerative areas (e.a.) are determined from the census. These are the smallest areas for which agricultural data are available. Non-agricultural e.a.'s are eliminated since there must be at least one farm within each e.a. There are approximately 10,000 such units.

Each province is stratified by land use with 8 to 12 strata within a province. A replicated sample of e.a.'s within each strata is selected. This is the first stage of the sampling plan.

Secondly, the e.a.'s are divided into area segments with the size of the segment dependent on the province. For example, in the prairie provinces a segment is three square miles while larger segments are established in the Eastern provinces. Natural boundaries are usually followed in determining the areas. Twenty to eighty segments per e.a. are selected with an average of five farms per segment required. Usually, about 1/30 of the segments are selected at the second stage. About 1500 to 2000 segments or 7000 to 9000 farms are selected. All farms which have part of their area within the segments are enumerated. Optimally, a sample size of 16,000 farms was desired, but the numbers have been reduced because of budgeting constraints.

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Figure 4.1 Questionnaire used by Statistics Canada for the 1976 Census of Agriculture.

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Section III - AREA OF FIELD CROPS, 1976		Acres
Enter the area seeded or to be seeded for harvest in 1976 of the following field crops		
6 Spring sown wheat (Do not include durum)		010
7 Durum wheat		011
8 Winter wheat (about last fall)		012
9 Oats for grain (Report area to be cut for green feed, hay or ensilage in Question 21)		013
10. Barley		014
11. Mixed grains (two or more grains sown together)		015
12. Fall rye for grain (sown last fall)		016
13 Spring rye for grain		017
14 Buckwheat		018
15. Dry field peas (Report cooking peas in Question 32)		019
16. Dry field beans		020
17. Corn for grain (Report corn for ensilage or fodder in Question 18, sweet and denting corn in Question 32)		021
18. Corn for ensilage or fodder		022
19. Alfalfa and alfalfa mixtures cut or to be cut for hay, ensilage or seed		023
20. All other tame hay cut or to be cut for hay, ensilage or seed (Do not include alfalfa and alfalfa mixtures)		024
21 Oats to be cut for green feed, hay or ensilage		025
22. Other fodder crops (to be cut for grain hay, green feed or ensilage) - Name		026
23. Flaxseed		027
24. Soybeans for beans		028
25 Sunflowers for seed		029
26 Rapeseed		030
27. Mustard seed		031
28. Potatoes grown mainly for sale		032
29. Tobacco		033
30 Sugar beets for sugar		034
31 Other field crops (safflower, castor crops for feed, etc.) - Name		035
Section IV - OTHER AREAS		
Enter the area in 1976 of the following		
32 Vegetables grown mainly for sale		036
33 Tree fruits (25 or more trees bearing or non-bearing)		037
34 Small fruits (strawberries, grapes, etc.) grown mainly for sale - Name		038
35 Nursery products, cut flowers and dry bulbs grown out of doors mainly for sale		039
36. Greenhouses and mushroom houses	040	040
37. Improved land for pasture or grazing (improved by seeding, draining, irrigating, fertilizing, or brush or weed control. Exclude area to be cut this year for hay, ensilage or seed)		041
38. Summer fallow		042
39. Other improved land (barnyards, lanes, home gardens, improved idle land, etc.)		043
40 Woodland (timber, sugar bush, seed wood-bushes, cut-over land, etc.)		044
41 Other unimproved land (unimproved hay land, native pasture, sloughs, marshes, etc.)		045
*42 *Total of Questions 6 to 41 (This total must equal the total area of the holding, Question 3)		

Figure 4.1 (Cont.)

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SECTION V - LIVESTOCK ON THIS HOLDING, JUNE 1, 1976

(Include livestock being pastured or fed for others; also include animals owned by you and being kept on community pastures.)

CATTLE

43. Total cattle and calves	None <input type="checkbox"/>	046
(If "none" ship to Question 50.1)		
(a) Cows and heifers, 2 years and over		047
(b) Heifers, 1 year and under 2		048
(c) Steers, 1 year and over		049
(d) Bulls, 1 year and over		050
(e) Calves, under 1 year		051
(The total of Questions (a) to (e) must equal the number given for Question 43.)		
OF THE COWS AND HEIFERS REPORTED ABOVE, HOW MANY ARE		052
44. Cows and heifers, 2 years and over, milking or to be milked?		053
45. Heifers, 1 year and under 2, being raised mainly for milk production?		054
MILK PRODUCED YESTERDAY		
46. How many cows and heifers were milked yesterday?		055 pounds
47. How many pounds of milk were produced yesterday?		

MILK SHIPMENTS, MAY 1976

48. Did you ship milk and/or cream to a milk plant or creamery in May?	No <input type="checkbox"/> - If "No" ship to Question 50 Yes <input type="checkbox"/> - Answer Question 49	
49. Where did you ship most of your milk and/or cream in May? (Mark an "X" in appropriate box.)		
1. <input type="checkbox"/> Fluid milk plant	2. <input type="checkbox"/> Industrial milk plant	3. <input type="checkbox"/> Creamery for butter
4. <input type="checkbox"/> Do not know		056

PIGS

50. Total pigs (all ages)	None <input type="checkbox"/>	057
(If "none" ship to Question 52.1)		
(a) Pigs, 6 months and over (include sows, boars and market pigs)		058
(b) Pigs, 3 months and under 6 months		059
(c) Pigs, under 3 months (born since March 1)		060
(The total of Questions (a) to (c) must equal the number given for Question 50.)		
51. Of the pigs 6 months and over (Question 50 (a)), how many are sows kept for breeding purposes? (Include bred gilts)		061

SHEEP

52. Total sheep and lambs	None <input type="checkbox"/>	062
(If "none" ship to Question 53.1)		
(a) Lambs, under 1 year		063
(b) Ewes, rams and wethers, 1 year and over		064
(The total of Questions (a) and (b) must equal the number given for Question 52.)		

OTHER LIVESTOCK

53. Kind and number of other livestock (horses, goats, mink, rabbits, chinchillas, etc.)	Name	None <input type="checkbox"/>	065
--	------	-------------------------------	-----

Section VI - POULTRY, JUNE 1, 1976

HENS AND CHICKENS

54. Total chickens (hens, pullets, roosters, chicks, etc., include broilers)	None <input type="checkbox"/>	066
(If "none" ship to Question 56.1)		
55. Hens and pullets, for laying		067
(a) Hens and pullets, 5 months and over kept for laying		068
(b) Pullets and pullet chicks, under 5 months, intended for laying		069
56. Other chickens for meat production under quota:		
(a) Broilers including Cornish (all ages)		070
(b) Roasters (all ages)		071
57. All other hens and chickens		072
(The total of Questions 55 to 57 must equal the number given for Question 54.)		

OTHER POULTRY

58. Turkeys (all ages)	None <input type="checkbox"/>	073
59. Geese (all ages)	None <input type="checkbox"/>	074
60. Ducks (all ages)	None <input type="checkbox"/>	

6-1000-15.1

Figure 4.1 (Cont.)

b. Estimates. Three types of estimates are routinely computed. Direct expansion estimates are used in all cases with the estimates differentiated on the basis of segment type: closed, open or weighted. Closed segments include all data for land within segment boundaries. Open segments consist of farms with headquarters within segment boundaries. In weighted segments data are weighted by the proportion of farms within the segment. These three different estimates are computed to give statistics which can be compared with other survey results. In general, there is a 2-8% coefficient of variation for crop estimates at the province level with an error for wheat of about 4 percent.

There is a six percent nonresponse rate which is equally divided between refusals and not-at-homes. Averages are used to provide these missing values.

4.2.3 Farm Expenditure Survey (FES). In 1977 an additional enumerated survey was introduced. The Farm Expenditure Survey was established for the purpose of obtaining data for grain stabilization legislation. The area frame was limited to the prairie provinces: Alberta, Saskatchewan and Manitoba. The enumerative areas were stratified by economic factors as well as land use. This stratum was introduced by Agriculture Canada for the purpose of making better statistical estimates.

This survey is conducted in March but uses reference data from the previous July for reporting purposes. Each operator is requested to report crop holdings as of the previous eight months. This does introduce a memory bias with its effect on overall results under study.

In 1978 the AES was discontinued from the prairie provinces and the FES was used in its place. This provided additional resources for other survey programs outside the prairie provinces.

Current efforts within the methodology section of Statistics Canada include assessing the validity of the FES and developing the increased use of lists for multiple frame surveys.

4.2.4 Mail Surveys. Questionnaires are sent out for both area and yield estimates to a panel of correspondents (farmers) who have been specially selected within stratified e.a.'s. A questionnaire has been designed specifically to obtain area estimates of crops in the prairie provinces (Figure 4.2). Recall that stratification in the prairie provinces is done by land use and economic characteristics. The list frame of respondents is checked each year for representativeness. The preliminary estimate of crop acreages is released in late August and is based on data which include results of the Agriculture Survey. Results of these surveys are analyzed using a change-ratio estimate together with data from the previous year and are then aggregated for crop districts.

4.3 Yield Estimates

All yield (and production) forecasts and estimates are based on results of mail surveys since there is no objective yield program. A mail questionnaire has been designed to provide data for estimating the



Statistics Canada Statistique Canada

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801 1

AGRICULTURE SURVEY

JULY 1978

PRAIRIE PROVINCES

PLEASE MAIL BY

JULY 5

Please correct any mistakes in Name or Address.

Si vous préférez recevoir ce questionnaire en français, veuillez cocher ☐

FARM STATUS INFORMATION AT JULY 1, 1978

PLEASE
ANSWER! →

1. Have you discontinued farming? Yes ☐ No ☐

2. Have you sold or rented out all or part of your farm? Yes ☐ No ☐

Office use only →

800-

check (✓) one box

3. Please report land area figures in: →

acres ☐
or
hectares ☐

199 1

AREA OPERATED AT JULY 1, 1978

4. Area Owned (exclude land rented to others) →

5. Area Rented from others →

6. TOTAL ALL LAND OPERATED (sum of 4 and 5) →

7. TOTAL CULTIVATED AREA OPERATED by you whether owned or rented from others
(include cropland, hay, seeded pasture land, summerfallow) →

Area	
290	
291	
802	
804	

Figure 4.2 Questionnaire for crop surveys in the Prairie Provinces.

TOTAL LAND USE

(operated by you whether owned or rented from others)

LAND AREA USED FOR:

	Area 1977	Area 1978
1. WHEAT (a) Spring (excluding durum and utility)	103 None <input type="checkbox"/>	203 None <input type="checkbox"/>
(b) Durum	104 None <input type="checkbox"/>	204 None <input type="checkbox"/>
(c) Utility	105 None <input type="checkbox"/>	205 None <input type="checkbox"/>
(d) Winter (harvested or to be harvested)	106 None <input type="checkbox"/>	206 None <input type="checkbox"/>
2. OATS	108 None <input type="checkbox"/>	208 None <input type="checkbox"/>
3. BARLEY	109 None <input type="checkbox"/>	209 None <input type="checkbox"/>
4. RYE (a) Spring	110 None <input type="checkbox"/>	210 None <input type="checkbox"/>
(b) Fall (harvested or to be harvested)	112 None <input type="checkbox"/>	212 None <input type="checkbox"/>
5. MIXED GRAINS (two or more grains sown together)	113 None <input type="checkbox"/>	213 None <input type="checkbox"/>
6. FLAXSEED	114 None <input type="checkbox"/>	214 None <input type="checkbox"/>
7. RAPESEED	115 None <input type="checkbox"/>	215 None <input type="checkbox"/>
8. SUMMERFALLOW	119 None <input type="checkbox"/>	219 None <input type="checkbox"/>
9. MUSTARD SEED	124 None <input type="checkbox"/>	224 None <input type="checkbox"/>
10. CORN (a) for grain	116 None <input type="checkbox"/>	216 None <input type="checkbox"/>
(b) for fodder and ensilage	117 None <input type="checkbox"/>	217 None <input type="checkbox"/>
11. TAME HAY (area cut or to be cut for hay or ensilage, exclude wild hay or seed)	120 None <input type="checkbox"/>	220 None <input type="checkbox"/>
12. SEEDED PASTURE (exclude area cut or to be cut for hay, ensilage or seed)	122 None <input type="checkbox"/>	222 None <input type="checkbox"/>
13. GRASSES and CLOVERS for seed	121 None <input type="checkbox"/>	221 None <input type="checkbox"/>
14. FORAGE CROPS seeded this year (without cover crop)	156 None <input type="checkbox"/>	256 None <input type="checkbox"/>
15. OTHER CROPS (please specify)		
16. TOTAL AREA CULTIVATED (sum of the above should equal Question 7, page 1) →	102	202
17. OTHER LAND (barnyard, woodland, wild hay, wasteland, winterkill not reseeded, home gardens, roads, etc.)	157 None <input type="checkbox"/>	257 None <input type="checkbox"/>
18. TOTAL AREA (sum of items 16 and 17 should equal Question 6, page 1) →	101	201

Figure 4.2 (Continued).

yield of field crops (Figure 4.3). Notice that an estimated average yield for a neighborhood is required of respondents. Results of these surveys are tallied and average yield per crop district is computed. Out-liers (in the distribution of results) are investigated and are either suppressed or replaced with the average value.

The assumption is made that average yield is distributed equally within crop districts of a province. So yield for a crop district is obtained as the product of average yield (based on results of mail surveys) and acreage of crop district.

4.4 Crop Reports.

Scheduled field crop reports for the current year are shown in Table 4.1. Forecasts and the preliminary estimate for area are issued three times: 7 April, 16 June and 25 August. The forecasts and preliminary estimate of production are also issued three times: 8 September, 6 October and sometime in November.

These reports are issued by the Field Crop Report Board whose members include the Head of the Crop Reporting Unit, marketing analysts, livestock statisticians, regional office personnel, Wheat Board representatives and financial analysts. Release figures are obtained after careful subjective analysis of all pertinent data.

On 20 January the final estimate for grain crops issued the previous November is revised considering the results of a survey conducted at the end of the year. As shown in Figure 4.2 crop area estimates are requested for both the current and previous crop year in the prairie provinces.

On 7 April planting intentions are reported. This is the basis for the first area forecast. Data from the previous year are collected for this report in order to compute change-ratio estimates. The survey results are also used in a land balance analysis for the Federal Labor Intensive Program.

Several surveys are conducted on a stand alone basis. These are distributed to a panel of grain producers in order to assess the bulk amount of grain stocks available. An independent supply-disposition analysis is done using this stock information. Subsequent survey results for yield and area are then compared with these results and with benchmark data which are revised if necessary. These surveys are conducted three times a year from stocks as of 31 March, 31 July and 31 December.

Telegraphic crop reports are received periodically during the planting, growing and harvesting seasons from a panel of grain elevator operators. This information consists of current grain holdings and economic outlooks.

Throughout the growing season forecasts and estimates of area and production and derived yield are issued based on analysis of data from the surveys described. A preliminary estimate of yield for principal field crops is issued in November after harvest.

STATISTICS CANADA
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PROVINCIAL DEPARTMENTS OF AGRICULTURE
Exemplaire français disponible sur demande

Authority - Statistics Act, Chapter 15,
Statutes of Canada 1970 11-72

SURVEY OF AREA AND YIELD OF CROPS ON SUMMERFALLOW AND STUBBLE, 1977

Over the years significant changes have taken place in the area seeded to various crops in your province and probably in your neighbourhood. The statistics already collected show up these changes. However, information is limited concerning the area of these crops sown on summerfallow and on stubble or second-crop land and the yields obtained from summerfallow and from stubble lands. This survey is an attempt to provide some answers to these questions. Your co-operation is very much appreciated.

**AREA AND ESTIMATED AVERAGE YIELD
PER SEEDED AREA ON SUMMERFALLOW
AND STUBBLE IN YOUR NEIGHBOURHOOD, 1977**

NOTE-1. Where a crop is not grown in your neighbourhood please mark with X.

2. The percentages of a crop seeded on summerfallow and stubble should add up to 100 — for example all wheat on summerfallow, 85; on stubble, 15; oats on summerfallow, 30; on stubble, 70 etc.

3. Where the yield of a crop was an entire failure in your neighbourhood please mark yield questions with O. For instance, if some grain was produced on summerfallow but stubble crop was a failure, please estimate summerfallow, but place O for stubble yield.

4. Where a crop was an entire failure or yields were unusually low, please indicate briefly the reason, for example — frost, hail, drought, insect damage, etc.

A metric conversion table has been provided for your convenience on this report.

Have you reported in metric units? 199-1 ☐

CROP (in your neighbourhood)	Code	Area seeded 1977	Code	Yield, 1977 per seeded area
All wheat	On summerfallow	101	per cent	201
	On stubble	102		202
Oats, harvested for grain	On summerfallow	103		203
	On stubble	104		204
Barley, harvested for grain	On summerfallow	105		205
	On stubble	106		206
Flaxseed	On summerfallow	107		207
	On stubble	108		208
Rapeseed*	On summerfallow	109		209
	On stubble	110		210

*Yield in bushels of 50 pounds.

PLEASE COMPLETE FORM AND MAIL IN ENCLOSED
POST-FREE ENVELOPE AS SOON AS POSSIBLE

WEIGHTS

Weights are expressed in
either kilograms or tonnes:

One tonne = 1,000 kilograms

One kilogram = 2.2 pounds

One ton = 0.91 tonne

Grain	Bushels	Metric Tonnes
Wheat	1,000	27.2
Oats	1,000	15.4
Barley	1,000	21.8
Mixed		
Grains	1,000	20.4
Rye	1,000	25.4
Flaxseed	1,000	25.4
Rapeseed	1,000	22.7

(1 Bushel of Rapeseed = 50 pounds)

**CONVERSION CHART:
ACRES TO HECTARES**

Acres Hectares

1 = 0.4
2.5 = 1.0
3 = 1.2
4 = 1.6
5 = 2.0
6 = 2.4
7 = 2.8
8 = 3.2
9 = 3.6

10 = 4
20 = 8
30 = 12
40 = 16
50 = 20
60 = 24
70 = 28
80 = 32
90 = 36

Acres Hectares

100 = 40
200 = 81
300 = 121
400 = 162
500 = 202
600 = 243
700 = 283
800 = 324
900 = 364

Figure 4.3 Survey of area and yield of crops on summerfallow and stubble.

Table 4.1 Field crop report calendar (3).

Note: The dates of issue and subject matter of regularly scheduled field crop reports to be released by the Agriculture Division of Statistics Canada during 1978 are listed below. All reports are issued at 3 p.m. E.S.T. or E.D.S.T. when in force.

No.	Date	Day	Title
1978			
1	January 20	Friday	Summerfallow and Stubble, Acreage and Yield of Specified Crops, Prairie Provinces.
2	April 7	Friday	Intended Acreage of Principal Field Crops.
3	April 21	Friday	Stocks of Grain at March 31.
4	May 11	Thursday	Telegraphic Crop Report - Canada.
5	May 18	Thursday	Telegraphic Crop Report - Prairie Provinces.
6	June 1	Thursday	Telegraphic Crop Report - Canada.
7	June 8	Thursday	Telegraphic Crop Report - Prairie Provinces.
8	June 16	Friday	June Intended Acreages and Progress of Seeding; Winterkilling and Spring Condition of Winter Wheat, Fall Rye, Tame Hay and Pasture; Rates of Seeding.
9	July 6	Thursday	Telegraphic Crop Report - Canada.
10	July 13	Thursday	Telegraphic Crop Report - Prairie Provinces.
11	July 27	Thursday	Telegraphic Crop Report - Canada.
12	August 10	Thursday	Telegraphic Crop Report - Prairie Provinces.
13	August 18	Friday	Stocks of Grain at July 31.
14	August 25	Friday	Preliminary Estimate of Crop and Summerfallow Acreages.
15	August 31	Thursday	Telegraphic Crop Report - Canada.
16	September 8	Friday	August Forecast of Production of Principal Field Crops.
17	September 14	Thursday	Telegraphic Crop Report - Prairie Provinces.
18	September 21	Thursday	Telegraphic Crop Report - Canada.
19	October 6	Friday	September Forecast of Production of Principal Field Crops.
20	October 12	Thursday	Telegraphic Crop Report - Canada.
21	November	(Date uncertain)	November Estimate of Production of Principal Field Crops, Area and Condition of Fall-Sown Crops; Progress of Harvesting in the Prairie Provinces.

In general, agronomic data are indirectly incorporated into the analysis procedures. Initially, soil types are discriminated by geographic stratification. Rainfall data are utilized by elevator operators and grain producers in estimating probable yield and economic outlook. There has been some work done with crop-weather modeling within Agriculture Canada, but this technique has not been fully developed as yet for general application.

In summary, the analysis procedures are qualitative but rely on several independent sources of information. Continuous feedback is provided by a network of sources. Thus, the quality of benchmark data is maintained between censuses.

4.5 Comments.

The findings on crop sampling procedures in Canada suggest that a reasonable amount of funding is available. While estimates of crop production are being made each year, there seems to be room for the improvement and implementation of a centralized, controlled sampling plan. An overall comprehensive probability sampling program for all major crops in Canada should provide improved crop production estimates.

4.6 Literature Cited

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CHAPTER 5

WHEAT STATISTICS METHODOLOGY IN INDIA

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CHAPTER 5

WHEAT STATISTICS METHODOLOGY IN INDIA

5.1 Agricultural Statistics in India

5.1.1 Organizational Structure. Collection and distribution of agricultural statistics are under the domain of the Directorate of Economics and Statistics in the Ministry of Food and Agriculture. Within the Cabinet Secretariat, the Department of Statistics is responsible for coordinating the various statistical agencies and setting up scientific standards for collection and compilation of agricultural statistics. The Ministry of Food and Agriculture also has an Institute of Agricultural Research Statistics established to conduct research and to develop statistical techniques for such tasks as objective crop yield estimates (2). The National Sample Survey (NSS) organization is responsible for supervision and technical guidance for the collection of statistical data such as crops and socio-economic statistics on various aspects of the national economy.

At the state level, responsibility for collection, compilation and coordination of agricultural statistics varies from state to state. However, each state is responsible for the collection of data and aggregation of estimates. State estimates are then submitted to the Directorate of Economics and Statistics.

There are no accurate figures presently available to show the magnitude and extent of inconsistencies in the estimation of crop production throughout the nearly 6.5 million square kilometers of the country. The States and Union Territories are subdivided into 338 districts comprising 20,689 towns and nearly 622,000 villages (2). To emphasize the problem further, it should be noted that with the exception of the states of Kerala, Orissa and West Bengal, the area of cropland is based on a complete enumeration done by revenue agents. In the case of these three states, crop area estimates are calculated from random sampling surveys (3).

Since India won her independence in 1947, official government policy has been to emphasize industrial growth and development. This may account, at least in part, for the lag both at the national and state levels in the organization and implementation of agencies to collect and analyze agricultural statistics. The pressure exerted upon India's land, vegetation and water resources by the rapidly expanding population, now in excess of 600 million, provides a great challenge to the agricultural sector. Only in recent years has there been a significant shift from the official emphasis on industrial and urban growth to more consideration for agricultural development (2). A part of this shift can be seen in a growing interest in agricultural statistics and crop yield estimates (3).

5.1.2 Crop Estimates and Forecasts. Crop forecasts have been prepared in India since 1884 when a circular was issued by the British Government to local Indian governments and administrations regarding the preparation

of forecasts of wheat yields. The system of preparing crop forecasts was extended to cotton, oilseeds, rice and jute crops in the following year. However, the collection of these data was merely incidental to the collection of land revenue which formed the principal source of finance for the state governments of the Indian Union; and even now, agricultural statistics in this country are largely the by-product of land revenue administration (10,11).

The preparation of crop forecasts, in the initial stages, was to limit the system of forecasts to the commercially important crops so that until 1943 crop estimates were restricted to only 11 crops, namely, rice, wheat, cotton, jute, sugarcane, groundnut, sesame, castor-seed, rape, mustard and linseed. In 1977, 70 forecasts were issued for 27 crops (1). Prior to 1948 crop forecasts were prepared and published primarily for the general information of the public and Government and secondarily for the benefit of trade. After independence the utility of such forecasts became essential for the collection of data relating to prospects of various crops for purposes of price and import-export potentialities as well as for the planning of development activities in the area of agriculture.

In general, two or three forecasts are issued annually per crop, the exceptions being cotton and castor-seed for which five forecasts and one forecast are issued, respectively. The first forecast is issued approximately one month following the sowing of the crops, usually at the time of germination and is generally related to the weather conditions. Several months later a second forecast includes the areas of late sowing and indicates the expected quality of harvest with information regarding the condition of the crop. The final forecast contains final estimates of the total area sown with regard to the quantity of crop. It should be noted that only the final estimate deals with quantitative estimates of the expected outcome of harvest; whereas the earlier reports provide information regarding environmental conditions which affect quality and in turn the quantity of the crop. Three forecasts are issued annually for wheat: first, planted area and seedling condition; second, expected yield and additional planted area; and third, estimated harvest. Area and yield estimates are published for public information and used by the Ministry of Food and Agriculture to formulate crop prices and export policies. Since the nature of the agrarian structure has a considerable influence on the efficiency of production, a census of holdings of cadastral survey of the country is conducted to determine if the area is owned by the person who operates the land, is rented or operated on a squatter basis. Further information of importance as an indicator of production is the amount of land operated by a single person (total area in hectares).

Area estimates are obtained from primary reporters in settled areas and revenue agents in temporarily settled areas. Yield estimates are obtained by one of three methods: (a) a percentage method where yield is the product of average yield and a crop condition factor; both are measured subjectively, (b) direct estimation by revenue officers, and (c) random sample crop cutting surveys which currently account for 99% of the wheat estimates and 95% of other small grain (11).

By the percentage method yield is obtained as the product of what are called the "normal per hectare" (or average yield) and the "condition factor." Both factors seem to rest on purely subjective considerations. The "normal per hectare" yield of a crop has been defined as "the average yield on an average soil in a year of average character" (10). Accordingly, the Agricultural Records Department in each state maintains a statement of the normal yield per hectare under two major headings: irrigated and non-irrigated land. These records are maintained for the crops in each district and are revised from time to time on the basis of crop cutting experiments on preselected plots.

The "condition factor" is the relationship of the present crop to the "normal crop per hectare" and is known as the anna estimate or the percentage estimate. For calculation purposes, "the percentage estimate is the American system under which 100 is taken to denote the normal crop and the estimated out-turn for the year of report is stated as the percentage of that crop" (1).

According to the method of direct estimation a prediction of the yield is made by the revenue agents in terms of maunds (measurement of weight) per hectare. This method involves complete enumeration of the crops in a given district.

According to the Directorate, random sample crop cutting surveys are conducted "in most of the important States" for the estimation of yield per hectare of rice, wheat, jowar (sorghum), bajra (millet), maize, ragi, barley, gram and tur and for the major non-foodgrains such as oilseeds, fibres, sugarcane, tobacco and tapioca. The usual method is to make a list of first-stage units, such as villages in the area to be studied. A sample of villages is then randomly selected and a list compiled regarding the fields growing the crop of interest. A subsample of fields is taken and a plot is marked at random in the selected field. The plot is then harvested and the crop is weighed after it has been dried. Specific details will be given in a later section.

Surveys in different areas of the country have shown that this method is capable of giving yield estimates free from bias with a relatively high degree of accuracy; usually within the sampling error of the survey when compared to complete enumeration. However, experience has also indicated that sample crop cutting surveys are expensive and nonsampling errors are high if close attention is not given to details.

5.1.3 Sampling Difficulties. Because of the importance of good organization and planning to control for nonsampling errors in survey work, a brief review of some of the problems encountered in the Indian crop cutting methodologies will be presented.

As mentioned above, area surveys are not conducted in most states. This is because they are complicated to organize, require a large number of trained survey personnel to coordinate and implement the survey and are therefore expensive endeavors (10). Other problems inherent in this type of survey work include the sample size, selection of sampling units and such complex things as size and shape of plots and "how" to stratify.

a. *Sample size.* The trend today in Indian sampling design for crop yield estimation is to choose a sample size with probability proportional to area under crop. That is when prior information is available regarding area under crop. Oftentimes this is not the case since obtaining this information requires pilot survey work of some type and consequently increases the expense of the project. While the variability between fields within a village is relatively high, the variability between plots in the same field is reasonably low. It has been recommended that sampling include more fields but only one plot per field. In considering the overall standard error, the greatest contribution to the variation in these surveys seems to be that between villages, so in order to minimize the variance of a given survey the technical approach should probably involve some type of double-sampling.

What all this demonstrates is that, given a 5% standard error, the estimation of crop yield per field can generally be accomplished by selecting two or three fields per village and one plot per field. The optimum allocation regarding number of villages (still depending upon a 5% margin of error) is determined by area under crop and then sample size is chosen with probability proportional to the total district area under crop. Since the greatest variability in these surveys is between villages, a great number of villages is selected to determine the amount of viable crop planted. From this first-stage sample, the subsample of fields is selected to estimate total yield. The combination of the area planted and yield produces the production estimate.

b. *Selection of sampling units.* Theoretically, the selection of sampling units (plots within fields in this case) is simple enough. In practice, however, the problems imposed by lack of manpower and financial resources make a sham of the theoretical simplicity. The use of revenue agents to obtain agricultural statistics greatly complicates the problem and introduces doubt into the credibility of any crop data they may obtain. Once a field is selected for sampling purposes, there is no assurance that the farmer whose land is being surveyed will not falsify the results in some manner for fear of taxation.

Among some of the other problems encountered is visiting the field at the appropriate time. Unlike the United States where a large number of trained enumerators are used, Indian Agriculture Departments have limited personnel to conduct surveys. When feasible, revenue agents are used, but often they lack the necessary training. Since a relatively short period is available to collect yield estimates, it is difficult for representatives to survey all selected sample fields. Attempts have been made to schedule survey dates, but this has the unfortunate disadvantage of taking the randomness out of the sample. It also offers those farmers who are frightened of potential taxation on a rich crop the opportunity to adjust the harvest weight by removing ears of corn or heads of wheat. There is also the risk under such a system that the crop will not be ready for harvest or that the harvest will be delayed. Both situations might lead to underestimation of the yield.

In attempts to overcome some of the problems created by scheduling, alternate methods have been tried. One such method is to go out to the field at time of harvest in a given area, select a cluster of fields and subsample from these fields. A problem with this procedure is that crops which ripen at different times are not adequately represented. Since the method of selection is based on the farmers information regarding which fields are ready for harvest, certain biases may creep into the estimates. Again, the farmer may not give accurate information to the enumerators regarding the "readiness" of his fields. In this type of cluster sampling the tendency seems to be to select two fields out of the cluster and then subsample from the two fields. If farmers indicate that the less productive fields are the ones ready at that time, an underestimation of the crop will occur. Investigations into this problem in sampling design (8) indicate that by taking a sample for all or a fixed proportion of the fields judged fit for harvest, more realistic estimates than subsampling from just two fields can be obtained. However, there is relatively no information regarding the willingness of individual farmers to provide accurate data.

c. *Stratification.* There is a strong tendency towards stratification by administrative districts within each state. The sampling plan is then designed with all practical considerations to achieve a precise estimate for each stratum. As mentioned before, within each stratum lists of first-stage units (villages) are made. A sample of villages is then selected with probability proportional to area under crop of the village. When the total number of villages to be selected in the entire sample is known, the number to be allocated to a stratum may be based on the proportion that the area under the crop in the stratum bears to the total area under the crop. If this information is not available, villages may be selected with equal probability. The selected villages are then subsampled by the random selection of a plot within each field.

d. *Size and shape of plot.* Much research has been done in the area of plot size and shape. Results of observations (7) indicate that the circle is the most efficient shape of plot for reducing biases (i.e., the tendency to include plants on the border of a cut is reduced because the circle has the smallest perimeter when compared to the triangle, square, rectangle of the same area).

5.2 Area Estimates

The National Sample Survey (NSS) is a multipurpose survey where data on two or more topics are collected in a single joint survey operation. The advantage of these surveys is that there is a better utilization of the available resources and an increase in the number of primary sample units. Thus, greater precision of individual estimates can be obtained. All technical work relating to planning and formulation of the sampling design, processing and tabulation of the data and preparation of final reports is done by the Indian Statistical Institute. Much of the field work is carried out by full time investigators, usually in conjunction with personnel from State Statistical Bureaus who participate in the survey (4). Land utilization and yield surveys as well as various socio-economic inquiries are undertaken in a common set of villages. Area data are obtained from selected plots by direct physical observation.

The overall sampling plan used is a stratified two stage design in which villages are the first stage units; households and clusters of plots form second stage units. For the yield survey, plots and circular cuts in them form the third and fourth stage units (4,8).

Strata were formed by grouping contiguous tehsils (administrative units) which were homogeneous with respect to 1951 census population density, altitude above sea-level and food crops, and equalizing strata populations as far as possible within each State. From each stratum circular systematic samples of 6 villages were selected with independent random starts after arranging the tehsils according to geographical contiguity to allow for interpenetration of investigators at stratum level. Such interpenetration helped in obtaining a quick estimate of the total error of the estimate including the differential non-sampling errors. For the land utilization survey, the required number of clusters of plots were selected systematically from the selected villages. In one-third of the villages, crop-cutting experiments were conducted for the cereal crops (4).

Estimates are then calculated using expansion methods. These estimates are used to supply the data required by the FAO World Census conducted every ten years when complete land records are not available.

5.3 Yield Estimates

At the present time 99% of all wheat production estimates in India are based on crop cutting surveys. This method consists of stratifying the land area and selecting cuts from plots as was described in the preceding section. Estimates are based on results obtained from harvesting the crop standing in the randomly selected cuts (9). The mean yield over all plots is then expanded according to a set of formulas (Appendix 5.1). The per hectare yield has a margin of error of about one to two percent at the state level and less than one percent at the national level.

Over several decades India has accumulated a large amount of experience in the objective measurements of yield by crop cutting. Many aspects of this experience have been documented (6).

5.4 Crop Reports

The focus of a good portion of literature reviewed in this study has been on sample selection methods and the overall sampling methodology. Much of the published work has concentrated on the finer details of random plot selection rather than detailing how crop estimates are aggregated for reporting purposes. Quantitative crop reports are issued on an annual basis (5).

An example of yield estimates for wheat is given in Table 5.1 (5). Recall that 'area under crop' is obtained from land revenue sources. Results of crop cutting experiments within wheat producing states are given. Sampling errors are reported for the majority of the states and are within the bounds previously stated. Note that the non-response rate varies from 10 to 31%. On the average, only 80% of the intended crop cutting experiments are completed.

Table 5.1 Area, yield and production estimates of wheat in India (5).

State	Area under the crops		Number of experiments		Response %	Estimated Yield (kgs/hectares)	Sampling Error %	Total Production '000' tonnes
	Total '000' hectares	Coverage %	Planned	Analysed				
1	2	3	4	5	6	7	8	9
1. Bihar	1,430	80	900	618	69	2,343	..	3,351
2. Gujarat	574	99	1,022	867	85	1,562	..	897
3. Haryana	1,172	100	700	670	96	2,043	..	2,304
4. Himachal Pradesh	333	100	816	591	72	1,317	4.4	395
5. Jammu & Kashmir	175	100	492	384	78	942	..	165
6. Madhya Pradesh	3,505	98	1,700	1,496	88	903	5.6	3,039
7. Maharashtra	1,009	100	2,150	1,486	69	498	..	503
8. Karnataka	347	99	320	291	91	337	5.1	114
9. Punjab	2,335	100	800	686	86	2,406	..	5,618
10. Rajasthan	1,524	95	1,000	920	92	1,249	3.0	1,904
11. Uttar Pradesh	6,046	100	3,650	3,040	83	1,266	..	7,550
12. West Bengal	253	100	775	657	85	1,341	2.7	339
13. Delhi	52	100	150	145	97	1,809	4.7	94
Total States	18,755	98	14,475	11,851	82	1,422	..	26,363

Includes I.A.D.P. experiments as indicated below:—

State	No. of experiments under I A D P	
	Planned	Analysed
Karnataka	40	29
Himachal Pradesh	300	255
Uttar Pradesh	450	301

I.A.D.P. - Indian Agricultural Development Project

5.5 Comments

Area estimation could be made on a more scientific basis than at present. The intensity of motivation of scientific investigations in the agricultural fields for developing methodology which was in evidence for several decades in the country seems to have weakened in recent years and matters seem to move on a routine level now. Being one of the leading countries of the world in the development of sampling theory and practice, especially for the use in the agricultural field, a great deal could be learned from the Indian experience. However, for obtaining reliable agricultural data, for example, on total yield of a crop, accurate estimation of average yield as well as that of the area under the crop are equally important.

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APPENDIX 5.1

NATIONAL SAMPLE SURVEY: ESTIMATION PROCEDURES FOR AREA AND YIELD RATE (4)

Crop Survey:

Estimation procedure used in 1959 National Sample Survey (NSS):

An estimator of the area under a given crop for a particular season based on a subsample or on the sample as a whole is given by:

$$\hat{A} = \sum_{s=1}^K \hat{A}_s,$$

where for a hilly stratum:

$$\hat{A}_s = \frac{N_s}{n_s} \sum_{i=1}^{n_s} f_{si} D_{si} \frac{H_{si}}{h_{si}} \sum_{j=1}^{h_{si}} g_{sij} r_{sij},$$

and for a plains stratum:

$$\hat{A}_s = G_s \left\{ \sum_{i=1}^{n_s} \hat{A}_{si} / \sum_{i=1}^{n_s} g_{si} \right\}, \quad \hat{A}_{si} = g_{si} \left\{ \sum_{j=1}^{h_{si}} g_{sij} r_{sij} / \sum_{j=1}^{h_{si}} g_{sij} \right\},$$

where $f_{si} = 1$ if the surveyed village coincided with the selected census village

= number of revenue villages contained wholly or partly in the selected census village, or

= inverse of the number of census villages contained wholly or partly in the surveyed revenue village.

An estimator of the yield rate for a particular crop in a season was obtained as follows from sample villages taken up for crop-cutting experiments separately for pure and mixed crops and within these separately for hilly strata and plains strata:

$$\hat{R}_y = \frac{\sum'_s \hat{A}_s \bar{y}_s}{\sum'_s \hat{A}_s},$$

where \bar{y}_s = simple average of yield rates over the cuts taken for the crop in the s-th stratum

\hat{A}_s = estimate of area under the crop obtained from the villages where land utilization survey was conducted.

\sum'_s = denotes summation over strata reporting crop-cutting experiments for the crop.

An estimator of production of crop was also obtained separately for pure and mixed crops and for hilly and plains strata separately, as product of the yield rate obtained as shown above from the reporting strata and the estimate of the area under crop based on all the sample villages in all the strata, that is,

$$\hat{P} = \hat{R}_y \hat{A}.$$

The final estimate was the sum of the four production estimates thus obtained.

The above estimates are for the green weight of the crop. The estimate for the dry weight was obtained by multiplying the final estimate for each State by a drilage factor. This factor was the ratio of the total dry weight to the total green weight of the crop (pure and mixed) obtained from the circular cuts of 2'3" radius for the whole State.

Variance Estimator:

If $\hat{Y}_i (i=1,2)$ is the i -th subsample estimate (unbiased) of the total value Y , then a combined estimate \hat{Y} is given by

$$\hat{Y} = \frac{1}{2}(\hat{Y}_1 + \hat{Y}_2) = \frac{1}{2} \sum_{s=1}^K (\hat{Y}_{s1} + \hat{Y}_{s2}),$$

where $\hat{Y}_{si} (i=1,2)$, is the i -th subsample estimate for the total in the s -th stratum. An unbiased estimator of the variance of \hat{Y} is given by

$$v(\hat{Y}) = \frac{1}{4} \sum_{s=1}^K (\hat{Y}_{s1} - \hat{Y}_{s2})^2.$$

Another estimate $v(\hat{Y}) = \frac{1}{4}(\hat{Y}_1 - \hat{Y}_2)^2$ can be given, but this is less efficient than the former one.

An estimator of the ratio between two totals $R = Y/X$ is given by

$$\hat{R} = \frac{\hat{Y}}{\hat{X}} = \frac{\hat{Y}_1 + \hat{Y}_2}{\hat{X}_1 + \hat{X}_2}.$$

An estimator of the variance of \hat{R} is given by

$$v(\hat{R}) = \frac{1}{4X^2} \sum_{s=1}^K (\hat{Y}_{s1} - \hat{Y}_{s2})^2 - 2\hat{R}(\hat{Y}_{s1} - \hat{Y}_{s2})(\hat{X}_{s1} - \hat{X}_{s2}) + \hat{R}^2(\hat{X}_{s1} - \hat{X}_{s2})^2.$$

A less efficient estimator of $v(\hat{R})$ but easier to compute is given by

$$v(\hat{R}) = \frac{1}{4} \left(\frac{\hat{Y}_1}{\hat{X}_1} - \frac{\hat{Y}_2}{\hat{X}_2} \right)^2.$$

An estimator of the variance of \hat{P} , the production estimate, is given by

$$v(\hat{P}) = \frac{1}{4} \left\{ \frac{\hat{P}_1'}{\hat{A}_1'} \hat{A}_1 - \frac{\hat{P}_2'}{\hat{A}_2'} \hat{A}_2 \right\}^2,$$

where \hat{P}' and \hat{A}' denote production and crop acreage estimates based on the strata reporting crop-cutting for that crop.

Notation:

- s subscript for s -th stratum;
 - i subscript for i -th village or selected part in i -th village;
 - j subscript for j -th household/cluster;
 - K number of strata;
 - N total number of villages;
 - n number of sample villages surveyed in the subsample (including uninhabited villages and excluding casualties not substituted) in a particular sub-round;
 - n' number of villages reporting price for a commodity;
 - D number of hamlet-groups for socio-economic survey/divisions for crop survey formed within the village ($D=1$ in case no such division was made);
 - H total number of households/highest survey number/highest sampling serial number of the plots;
 - h number of sample households for the schedule/plots surveyed in the round/sub-round/season (excluding casualties not substituted);
 - y value of the study variable (in the case of dichotomy, this value is 1 if the unit belongs to the class, otherwise 0);
 - G total geographical area of stratum;
 - g geographical area of sample village/cluster;
 - p price of the commodity;
 - r proportion of area under particular type of land utilization;
- $\sum_{i=1}^n$ summation over a sample.

CHAPTER 6

WHEAT STATISTICS METHODOLOGY IN THE SOVIET UNION

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CHAPTER 6

WHEAT STATISTICS METHODOLOGY IN THE SOVIET UNION

6.1 Agricultural Statistics in the Soviet Union

6.1.1 Use of Agricultural Statistics in a Centrally Planned Economy.
The methods used in obtaining and disseminating agricultural statistics in the Soviet Union is significantly different from the methods used in the other four countries included in this study. In this centrally planned economy the methodology can best be understood by describing the political structure in which agricultural statistics are generated.

The political system consists of the Government and the Communist Party of the Soviet Union. The Party establishes the policy and goals for every aspect of the economy. The Government is a parallel structure responsible for the administration of Party plans. Administratively the country is subdivided into the following units:

- Kray - territory
- Oblast - region (similar to a state in the U.S.)
- Ohrug - district
- Rayon - county

The Soviet economy is centrally planned with a foundation based on a socialist system of public ownership of real estate and the means of production. Government policies are established in the form of five year plans. The eighth plan (1966-1970) was successfully completed. Since it was not possible to achieve the high goals set for the ninth plan (1971-1975), more realistic, lower goals were established for the tenth and current plan (1976-1980). The tenth plan includes:

- a. Greater emphasis on agriculture with 25% of national investments for agricultural development;
- b. Increase the national income by 24 to 28%;
- c. Increase industrial production by 35 to 39%;
- d. Increase consumer goods by 30 to 32%;
- e. Increase trade with the West.

All trade, production, banking and finance are controlled by the State. Trade and distribution within the USSR are controlled by the Procurement Ministry, consumer cooperatives and collective farm markets. Foreign trade is a state monopoly and controlled by the Foreign Trade Ministry.

As a net importer, the Soviet Union ranks seventh in agricultural imports and tenth in agricultural exports. Soviet trade with the West is increasing and in 1975 amounted to one-third of total Soviet trade.

Since the Soviet Union operates under a centrally planned economy, the primary function of statistical data is to describe progress in the plans of the State. All economic decisions and prices are decided by the State. In fact, agricultural data and statistics have no practical value to the worker on the state and collective farms. Government officials and party planners are the only groups with the authority or ability to utilize such information. Agricultural data in the West serve very different purposes.

6.1.2 Acquisition and Processing Data in the Soviet Statistical System. The Central Statistical Administration (CSA) is a specialized agency of the Government responsible for collecting, processing and publishing statistical information, including most agricultural data (1). CSA has the same status as an all-union ministry and is attached to the Council of Ministers. There is also a CSA in each of the union republics with a chain of offices and subdivisions descending from the republic through the oblast, the rayon, and the state and collective farms. A hierarchy of responsibility within the Agricultural Statistics Division of the CSA structure has been carefully defined (Figure 6.1). The collection of agricultural statistics begins on the collective and state farms. Statistics are aggregated upward through the rayon, the oblast and the republic. Relationships among all participants in the agricultural statistical system in the Soviet Union have been designed to provide final statistical results to the CSA (Figure 6.2).

The CSA has a "broad mandatory authority" in that "organizations, enterprises and farms must make available any statistics and accounts concerning their activities when requested by CSA" (3). Further, no organization can collect statistical information in the Soviet Union without the approval of CSA.

6.1.3 Total Enumeration of Crop Data. Uniform procedures and standard forms are used at scheduled times to obtain total enumeration of crop data from state and collective farms in the Soviet Union. These data include:

- area, yield, production
- inventory of materials and equipment
- production inputs (labor, fuel, chemicals)
- daily progress in field operations (plowing, seeding, cultivation, harvesting)

Data are documented in ledgers in the offices of records on the state and collective farms. Weekly data are usually transmitted by telegraph or telephone to the statistical office of the rayon. A written confirmation of the data is prepared and transmitted also. The data are classified according to use, accessibility, time and frequency (Table 6.1 and 6.2).

6.2 Area Estimates

Statistics for areas of different crops are aggregated from the total enumeration of all cultivated lands on state and collective farms. No statistical sampling design for area estimates as employed in some countries is used in the Soviet Union except for agricultural production in the private sector.

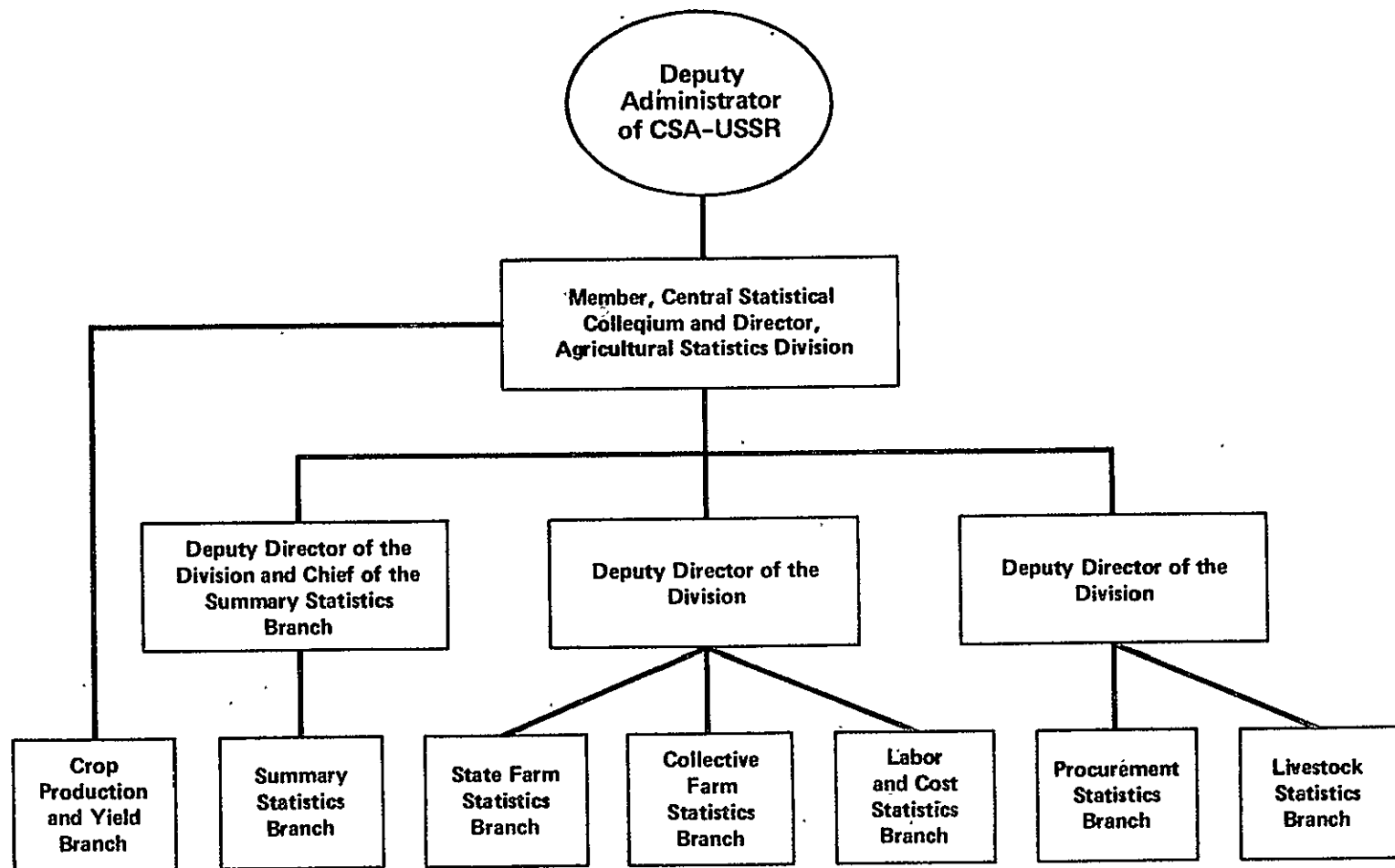


Figure 6.1 Organizational diagram of the Agricultural Statistics Division, Central Statistical Administration, Council of Ministers of the USSR (3).

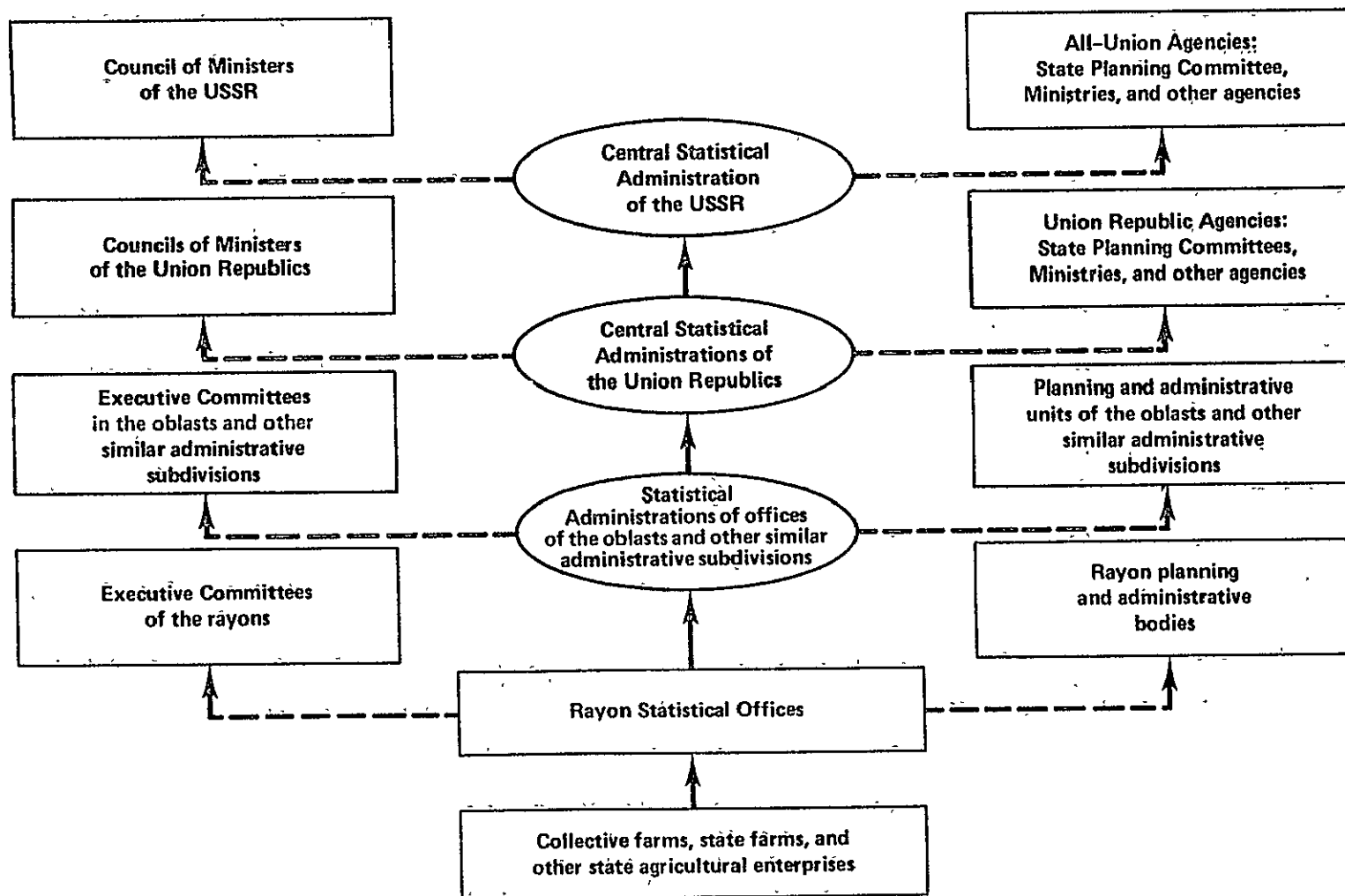


Figure 6.2 Structure of the agricultural statistical system in the Soviet Union (3).

Table 6.1 Classification of data by use and accessibility (3).*

	<u>Statistical</u>	<u>Operational</u>	<u>Bookkeeping</u>
Collection Procedure	Collected openly by the CSA.	Collected openly by the CSA, a Ministry (finance, procurement or agriculture) or other authorized government organization	Data reported by the Ministry of Finance, using forms as authorized by the CSA.
Assessment	Less detailed and more significant than bookkeeping data.	Soviets very secretive as to the types and amounts of data in this category. Data used solely in managing a farm or other enterprise, a ministry, oblast or republic or USSR economy.	For internal use and flow through the ministries involved rather than the CSA.
Publication	Published openly in statistical handbooks, newspapers and journals. Sometimes there is a restriction as to when information may be published, but can be published at any administrative level.	Data not published; available only to Soviet officials.	Data used in calculating cost of production, financial statements and productivity.

* A single piece of data might fall under more than one category.

Table 6.2 Classification of data by time and frequency (3).

Information Content	<u>Periodic</u>		<u>Annual</u>
	<u>Weekly</u>	<u>Monthly</u>	
	Reports specific details of an operation to a specific date or time period.		Complete picture of economic activity and results over the year.
	Progress reported on a specific operation as of Monday morning: -Spring seeding (4/1 to 6/15) -Harvest and production (7/1 to 10/1) -Seeding and Fall plowing (8/15 to 10/15)	Primarily livestock data. Seasonal monthly reports on crop cover, amount and quality of seeding, inventories and condition of machinery.	Comprehensive report by each farm submitted concerning all aspects of the farms' operation including inventory of all products, equipment and supplies.
Processing	Processed rapidly within 2½ days): -Farm to Rayon Inspector to Oblast Statistical Office to CSA (Union Republic) to CSA (USSR) to Government newspaper.	Processed less quickly. Reported first of the month and available in appropriate newspapers and administrative offices by the tenth of the month.	Material reported at specific dates travels through the CSA structure and an aggregate account of the entire country and regions is made.
Use	Material used as an indicator of progress towards meeting prescribed agricultural goals.		Information used in formulating agricultural plans and assessing success or failure of previous state plans. Note that sown area is reported at end of June while harvest and production data are submitted and aggregated during second half or end of October. Production data are released at November celebration.

It has been estimated that 97% of the cultivated area in the Soviet Union is in state and collective farms and other state-sponsored establishments. The remaining 3% is under private control and management. Since the total enumeration of crop data applies only to the farms under state control, the CSA has initiated sample survey methods to obtain information about the contributions to total agricultural production by the private sector. Sample survey methods are limited to special studies and to the "family budget survey." The family survey consists of more than 2,000 questions concerning family employment, income, expenses, cultivated land, crops grown, and crop production.

Two-fifths of the oblasts are surveyed. One enumerator is assigned to every 22-25 families. Families are surveyed once a month throughout the year. Some families have been surveyed for a number of consecutive years which may have some effect on the data with respect to respondent burden.

The U.S. Central Intelligence Agency (CIA) criticizes this survey because only the middle and upper classes are sampled. The CIA suggests that the largest contributor to agricultural production in the private sector may be the unsurveyed lower income class (1).

6.3 Yield Estimates

No organization has as yet been assigned the responsibility for making official forecasts of Soviet crop production. The Soviet Hydrometeorological Center (HMC) and the Ministry of Agriculture have been doing some work on forecasting grain production (3). The HMC has reportedly perfected methods to estimate yields for specific grain crops for a few of the oblasts. The Agriculture Ministry is studying methods of grain crop estimation using factors of weather, crop variety, fertilizer applications, cultural techniques and fallow cropping.

In addition to these efforts, the Hydrometeorological Service collects and compiles reports on weather conditions and crop development three times a month. Publication of this information is limited to use by Soviet Government officials. Summaries of the more significant results are published in Soviet agricultural newspapers (3).

Additional data collected but not analyzed include detailed information on sown area and agro-technical features (2):

Sown Area

- Areas under winter and summer crops to be harvested in the current year.
- Size of areas for perennial grasses for hay.

Agro-technical Features

- Introduction and correct use of crop rotations;
- Conditioning of soil for agricultural crops;
- Application of mineral and organic fertilizers;
- Quality characteristics of seeds;
- Management of sown crops.

Data on the yield and, therefore, production of agricultural crops cover only the harvested product. The quantity lost in harvesting, transport and threshing is not included. The mean yield rate of agricultural crops in the spring production area is determined by the gross production divided by the total number of hectares sown.

The yield of grain crops and sunflower is assessed on the basis of "bunker weight." This is the weight of grain where foreign matter (trash) and excess moisture are included.

Each year the state statistical bodies collect and process the crop yield accounts of collective and state farms and other state-sponsored establishments. On the basis of these data, the annual accounts of various farming establishments and surveys of crops from the private sector, the preliminary and final yield rates and gross production are determined for all agricultural crops.

According to the Economic Research Service, U.S. Department of Agriculture, the information on agricultural production and crop statistics published by the Soviet Union is reasonably accurate (4). Accuracy may be inferred from the following practices:

- a) Complete enumeration of collective and state farms is mandatory and penalties can be imposed for nonparticipation; little or no problem is encountered with nonresponse.
- b) Two or more people are usually involved in any measurement activity or primary data collection.
- c) Counting and scales are used extensively.
- d) The entire country uses a uniform system of statistical procedures and standard forms.
- e) Special CSA units periodically audit farms accounts and records.
- f) Whenever accuracy is questioned, a special investigation may be conducted.
- g) Winter wheat estimates include forage; harvest data for grain is based on windrows.

Errors are acknowledged, but the Soviets feel these are limited to newcomers or inexperienced personnel. Significant reduction of errors has been reported since the 1961 decree regarding penalties for falsification of data. A U.S. team of observers has suggested there may be discrepancies between the theoretical operation of the statistical system and its actual operation (3).

"Manpower" is probably the most costly item of the Soviet statistical system. Since most primary data are collected on the farms by workers, the various statistical offices function to compile and update collected data. Equipment of the statistical offices appears to be appropriate for each level of processing. Overall, Soviet equipment is being updated:

- Rayon: Desk calculators and abacuses are used; rayon information-calculating stations are replacing rayon statistical offices.
- Oblasts: Computer centers are replacing traditional oblast statistical offices.
- CSA-USSR and Republic Centers: These centers have computerized facilities. They receive, keypunch and process the data.

6.4 Crop Reports

Agricultural statistics for the Soviet Union are reported regularly in a variety of publications, all controlled by the Government or the Party. These include:

- a. Weekly progress reports:
 - News (Soviet Government newspaper)
 - Rural Life (Soviet agricultural newspaper)
 - Pravda (Party newspaper)
- b. Monthly journals:
 - Statistical Herald
 - Miscellaneous special reports
- c. Annual statistical handbooks:
 - The USSR in Figures
 - The National Economy of the USSR
 - Agriculture in the USSR
- d. Miscellaneous handbooks and special reports published by the CSA-union republics and other ministries (Published only after approval by CSA-USSR).

In general, Soviet policy is one of secrecy and selectivity as to who is permitted to receive, process or use statistical information. Government and Party officials, rather than Soviet farmers, are the primary users of agricultural data. Annual reports are used extensively by Soviet agricultural officials and other economic planning agencies for developing agricultural goals and for determining the required inputs to fulfill these goals (3). Soviet economic research institutes use these reports and results of special studies to assist with agricultural production problems. Periodic reports are used at the appropriate administrative levels to monitor production and make adjustments as problems arise.

During recent years the Soviets have entered the world grain market more extensively than before. This activity may provide the incentive for them to do more crop production forecasting than is freely reported today.

6.5 Comments

Crop area estimates released regularly through the press during the growing season provide timely information about how many hectares of wheat (or other crops) have been planted and how many have been harvested. However, there is no timely public release of crop yield and production estimates.

Area estimates are made by complete enumeration of state and collective farms. It would be relatively simple in this centrally planned economy to implement a probability sampling program which would provide timely estimates of yield and production. Whatever method the Soviets are using to predict wheat yield and production, the results are not made public until many months after the harvest has been completed.

Since the fields of wheat in the USSR are extremely large, crop surveys from satellite-derived data appear to hold great promise.

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CHAPTER 7

WHEAT STATISTICS METHODOLOGY IN THE UNITED STATES

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CHAPTER 7

WHEAT STATISTICS METHODOLOGY IN THE UNITED STATES

7.1 Agricultural Statistics in the United States

One of the major activities of the United States Department of Agriculture (USDA) is the collection and dissemination of statistics related to the production and supply of the major crops of the world. Reports on domestic and foreign crop production are published regularly (1). Responsibilities within the USDA for crop reporting are assigned to three agencies: the Economic Research Service (ERS), the Foreign Agricultural Service (FAS) and the Statistical Reporting Service (SRS). The ERS analyzes the long range effects and economic implications of both domestic and foreign crop production. The FAS prepares and publishes foreign crop production estimates. The SRS is responsible for the collection and analysis of data and the reporting of domestic crop production forecasts and estimates. This chapter will describe the methodology used in the reporting of domestic crop production statistics.

Although there are many users of the regular crop reports issued by the USDA, many industries supplement the USDA statistics with data obtained through corporate or other information systems.

7.1.1 The Statistical Reporting Service (SRS). The Statistical Reporting Service consists of five separate divisions which have specific duties within the domestic crop reporting system (7).

a. *Research Division*. The Research Division is responsible for the development and improvement of collection procedures and estimation and forecasting methods. Sampling techniques, yield models, remote sensing applications, and construction of area and list frames are representative of current research endeavors.

b. *Estimates Division*. The Estimates Division implements the procedures for the analysis and interpretation of agricultural statistics.

c. *Survey Division*. The Survey Division prepares and establishes the procedures for data collection by the State Statistical Offices including designing questionnaires, writing data collection instructions and conducting training schools for enumerators.

d. *State Statistical Offices*. The State Statistical Offices are primarily responsible for data collection and processing. General procedures prescribed by the Survey Division are adapted to local circumstances

e. *Crop Reporting Board.* The Crop Reporting Board reviews and adopts official state and national estimates for crops and livestock.

7.1.2 SRS Methodology. In general, surveys conducted by SRS are small sample surveys. In the past when most data collection was done using mail surveys, nonprobability sampling procedures were used primarily because of inadequate sampling frames. Analytical techniques were developed using results of the Agricultural Census which was conducted every five years. Census data were used as a benchmark against which to evaluate results of nonprobability surveys and remove any obvious bias. Reasonably accurate estimates were obtained under this system which has since been replaced by a national probability sampling plan (1).

Currently, methods of stratified random sampling have been implemented for both area and yield estimates. Initially, a random sample of farmers is interviewed to obtain information regarding planting intentions and is followed with surveys to obtain estimates of actual area planted. Yield and production forecasts are made during the growing season; and finally, estimates of harvested area, production, and disposition of the crop are reported. There are three basic methods used to obtain this information: mail surveys (voluntary), enumerative surveys, and objective measurements of sample plots (7).

Mail surveys are relatively inexpensive but cannot be considered at all random and often produce about a 30% return, thus giving a nonrepresentative sample. Their chief utility is to provide indications of the current crop status which might signal certain agricultural influences which would otherwise go undetected.

Enumerative surveys are constructed on the basis of a national sample of area segments. Interviews are conducted in June and December (December segments are a subsample of those selected the previous June) to obtain estimates of planting intentions and actual area planted. The state estimates are less precise than the overall national estimate but are used in conjunction with estimates from mail surveys.

Objective measurements are taken during the growing season for randomly chosen plots within the fields selected from the same population used in the enumerative surveys. These measurements include actual counts and clippings of numbers of heads, stalks, and kernels.

The methods of collecting, analyzing and reporting agricultural information are prescribed by the SRS and carried out by the state statistical offices. The Crop Reporting Board receives the individual state summaries and releases the official national estimates.

An overview of the U.S. crop reporting process is shown in Figure 7.1. A detailed discussion of procedures to obtain both yield and area estimates as well as the operations of the Crop Reporting Board will follow.

Statistical Reporting Service
State Statistical Offices (SSO)

Washington, D.C.

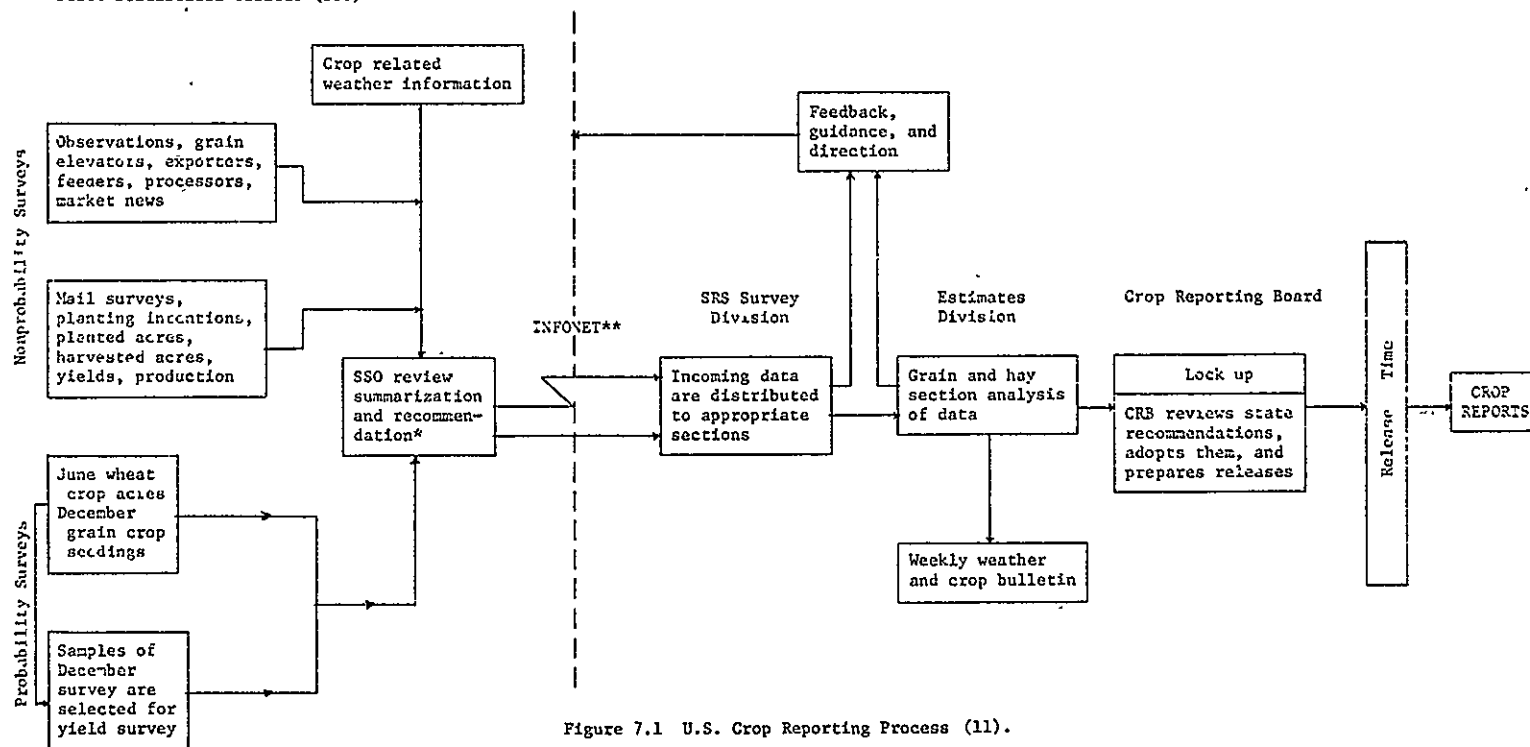


Figure 7.1 U.S. Crop Reporting Process (11).

*Speculative data are scaled and sent to the secretary of the Crop Reporting Board.
**Used when available (Computer Network).

UNRELIABLE
OF POOR QUALITY

7.2 Area Estimates

The SRS makes area estimates for all crops of economic significance in the United States. In this discussion of the methodology for determining area estimates descriptions will be given of the general sampling plan, the enumerative survey methods, and the SRS procedures used specifically for making area estimates for wheat.

7.2.1 Sampling Plan. Area frame sampling is the most widely used method for obtaining a representative sample of the population of farms in the United States, according to William Kibler, director of the SRS Estimates Division (3). "Area frame," as it is used here, simply means the total land area of the United States from which samples are randomly selected. Another method of sampling might start with a list frame, a list of all farms or farmers in the United States, from which samples could be randomly selected.

The first area frame was developed in the 1940's and was called the master sample of agriculture. Its intended use was to obtain information about the farm sector and thus the sampling strategy aimed at dividing the total rural area into blocks, each having the same number of households. Households are selected at random and interviewed for the desired information. This particular frame strategy was replaced by the land use area frame where blocks are equalized with respect to land area (7).

a. *Area Frame*. The area frame used by the SRS consists of the total land area of the U.S. (2). This land area is divided according to broad land use classes such as agriculture, recreation, and urban. In particular, the agricultural class is stratified into four strata using percent cultivated as the stratification variable. The strata definitions are:

Stratum 11: more than 75% of land in cultivation
 Stratum 12: between 50% and 75% in cultivation
 Stratum 20: between 15% and 50% in cultivation
 Stratum 40: less than 15% of land is cultivated.

Once a sample has been selected using an area frame, estimates can be computed from the data collected within the selected sample. For example, if the entire population is divided into N segments of which n are selected at random, the desired data are obtained from the sample of n segments and then the estimate of the population value is found by multiplying the sample total by N/n (12).

According to SRS officials this sampling technique has both advantages and disadvantages. It is extremely expensive since, in most cases, it requires an enumeration of all or a large portion of the sample units. However, an important advantage is that since each tract (land area under a single operator) or farm within the population has a known probability of being selected, estimates which are unbiased can be derived from the sample data. Another advantage is that the precision of the estimates can be measured by computation of the sampling errors for each estimate (3,5). The coefficient of variation (standard error of the estimate/value being estimated) varies from 1 to 3 percent at the national level and from 2 to 6 percent for state figures. These statistics are used to evaluate how well the estimates represent the true value being estimated.

b. *Interpenetrating Samples.* Currently, samples are selected using the technique of interpenetrating or replicated sampling which consists of drawing r samples or replications, with r greater than 2, of size k from N units in the population using the same selection procedure for each replication. A selection procedure using interpenetrating sampling with systematically selected replication from an area frame is detailed below (4). Prior to sample selection, the number of segments to be chosen from each stratum is determined primarily by cost and desired variance.

Each stratum is split into count units. A count unit is a specific area of land with an assigned number of sampling units. The number of sampling units assigned to a count unit is the quotient of the area in the count unit divided by the expected segment size. The number of sample units is rounded to a whole number for the count unit. Count units in a stratum are grouped by counties. Counties are ordered in a manner to preserve geographic proximity with adjacent counties that appear to be agriculturally similar being placed together.

After the number of segments has been allotted to each land use stratum, the number of replications and paper strata in each land use stratum must be determined. Paper strata may be defined as a group of contiguous count units (or sampling units) thereby creating geographic stratification. A list is compiled of the ordered count units in a land use stratum, the number of sample units each count unit contains and an accumulated total of sampling units in the stratum. The count units in a land use stratum are grouped into paper strata, each containing an equal number of sample units.

The number of paper strata (k_i) is equal to the cluster size of each replicate and the sampling interval is N_i/k_i where N_i is the total number of segments (or sampling units) in the i^{th} stratum.

If n_i = number of segments allotted to the sample in the i^{th} stratum,
 r_i = number of replications allotted to the i^{th} stratum,
 k_i = number of paper strata allotted to the i^{th} stratum,

then $n_i = r_i \times k_i$ or $k_i = n_i/r_i$.

If systematic selection within replications is desired for stratum i , then r_i random numbers will be selected in the first paper stratum. Selection of segments in other paper strata will be determined by adding a sampling interval to the random numbers selected in the first paper stratum. This procedure results in only r_i random samples (or total degrees of freedom available for error) rather than n_i corresponding to the total number of segments in the i^{th} stratum. Sampling in other strata is done in a similar manner.

The interpenetrating design offers several advantages over one single systematic sample previously used by the SRS. Replicated systematic sampling permits the computation of unbiased estimates of the sampling errors from the sample data and maintains the ease of the systematic selection technique. Sample dispersion is assured; however, the design gives somewhat less control on where the segments fall than with a single systematic sample. Another feature of the design is the creation of paper strata which provides geographic stratification in addition to land use for modifying the survey design and makes reallocation of the sample possible at any time without

a complete redraw. Sample rotation may be varied from stratum to stratum and achieved by deleting complete replications. Additional samples will become available to increase sample size of a given survey or to create multiple samples as a by-product of rotation (4).

7.2.2 Enumerative Survey. Since the area frame is a complete sampling frame, it can be used in the implementation of an enumerative survey requiring a complete accounting of segments in the selected sample. SRS uses enumerative surveys to gather data for area estimates. Trained enumerators conduct personal interviews with all operators within selected segments to account completely for land area and use for every field within the sample.

The principle enumerative survey is conducted during the final week of May and the first week of June and is called the June Enumerative Survey (JES). The information collected on this survey concerns crop area and land use, inventory of livestock holdings and farm related factors such as labor.

a. *Sampling Scheme*. Segments are selected within each state using the land use strata based on percentage of area under cultivation described above with all strata weighted equally. The sampling plan may be characterized as a stratified two-stage design with systematic interpenetrating samples. The primary units are segments with all tracts within the segments being enumerated. Segments are allocated so that the resulting national estimate will have a sampling error of about 1 to 3% with state estimates being within 6%.

b. *Allocation*. For the JES, the area frame sample includes about 16,000 segments which total about 115,000 distinct farm operations (tracts). A segment covers roughly one square mile. The number of segments varies for each state according to land area and agricultural productivity. Most states in the Midwest have about 350 segments while those in the South have about 450. Texas and California have the largest numbers of segments, with 850 and 1,000, respectively (7).

In addition, a quality check is carried out in July using a subsample of 11,000 tracts from the JES. The information from this survey is also used to update planted and harvested acreage estimates based on the June survey. Another subsample of 20,000 tracts is selected and the December enumerative survey is conducted during the last week of November and the first week of December. Livestock is mainly emphasized in the December survey, but information is also obtained on fall seeded wheat and rye.

c. *Estimates*. The primary result of these surveys is direct expansion estimates of area. Additional indications from these surveys include ratio estimates of current to previous year's data as well as ratio of area planted to total area per farm. Estimates are computed in general for each stratum within a state (though not published). Strata are summed within each state with inference from the survey restricted to state forecasts and estimates to reduce sampling error.

Other indications used to estimate area planted and harvested are results of national nonprobability mail surveys as well as monthly state surveys. Returns are very low (25-30%) and the sample is not at all random. These surveys provide ratio estimates of crop area to total farm

area and percentage change from previous year when matching reports are available. Regression charts showing the relationship between past area indications and final area estimates are used to evaluate current indications. Interpretation may be done visually or by using a linear regression line to assist in the analysis (7). Standardized mail survey forms for reporting acreage and production of grain crops are used by grain producing states (Figure 7.2).

d. *Respondent Burden.* Two problems in the survey methodology are missing data and the effects of respondent burden. Bruce Graham, chairman of the Crop Reporting Board, has indicated that the improvement of deteriorating response rate to SRS surveys is one of their problems of greatest concern in the foreseeable future (8).

The procedure for selecting samples for the JES is to use a rotating sampling scheme to eliminate the expense of selecting a completely new sample each year. Now, 20% of the sample units are rotated out each year and replaced to form the current year's sample. This plan permits more accurate ratio estimates and measures of change from one year to the next. However, there remains the concern that not only are a group of respondents sampled repeatedly from year to year but subsamples of the JES sample are selected for many additional surveys. So, a respondent may be requested to complete numerous survey questionnaires.

The problem of respondent burden results in missing data and poorer data quality. Missing data for an area frame sample is imputed by the statistician on the basis of information from a variety of sources. Refusal rates can vary from 5 to 15% in various states. Sometimes survey responses can be obtained from neighbors or from observations of the enumerator. However, the quality of these imputed or estimated figures has not been studied nor has the effect of imputed data on accuracy been examined (8).

7.2.3 Area Estimates for Wheat. The SRS has developed a standard procedure, including dates and tasks, for making monthly area estimates for spring and winter wheat in the United States. Estimates reported on 1 May and 1 July are based on enumerative surveys. All other estimates are taken from data recorded during the monthly objective yield study.

The following outline describes in chronological detail the tasks and methods used by SRS for determining area estimates for wheat through a growing season (9).


a. *1 May Winter Acreage for Grain Estimate.* The December Enumerative Survey estimate of winter wheat planted acres is the base for the 1 May estimate of acreage for harvest. The "Direct Expansion Estimate" is adjusted to acres of grain for harvest using a ratio obtained from data reported on the Objective Yield interview questionnaires. The ratio of "acres for grain in tract as reported in the 1 May Objective Yield Survey to acres seeded in tract as reported in the December Enumerative Survey" provides an estimate of acres for grain.

b. *1 June Winter Wheat Acreage for Grain Estimate.* The 1 June estimate of acres for grain harvest is obtained by the following methods:

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 Crop
Reporting
Board
Statistical Reporting
Service
U.S. Department
of Agriculture

INDIANA CROP REPORTING SERVICE
Agricultural Administration Building,
Purdue University,
West Lafayette, Indiana 47907

 Form Approved
O. M. U. Number 40-R0127
Approval Expires 7-31-77
C.E. 02-9826E

ACREAGE AND PRODUCTION OF GRAIN CROPS - 1976

Dear Reporter:

The information requested on this inquiry is needed for preparing final estimates of acreage and yield of small grain crops this year. Please fill in the information as completely and accurately as possible, and return this inquiry in the enclosed envelope which needs no stamp. Your report will be kept confidential.

Sincerely,



Earl L. Park
Agricultural Statistician in Charge

Please make corrections in name, address and Zip Code, if necessary.

INSTRUCTIONS: Please report for each crop listed below the planted acreage and use made of the planted acreage. In reporting acres harvested and production, include acres that still remain to be harvested and probable production.

REPORT FOR ALL LAND YOU OPERATE	Answer here
1. Wheat planted for all purposes last fall and this spring..... Acres	680.
2. Wheat harvested for grain..... Acres	685.
3. Wheat used for hay, silage, pasture only, plowed under or abandoned..... Acres	690.
4. Oats planted for all purposes last fall and this spring..... Acres	710.
5. Oats harvested for grain..... Acres	385.
6. Oats used for hay, silage, pasture only, plowed under or abandoned..... Acres	388.
7. Barley planted for all purposes last fall and this spring..... Acres	391.
8. Barley harvested for grain..... Acres	403.
9. Barley used for hay, silage, pasture only, plowed under or abandoned..... Acres	001.
10. Rye planted for all purposes last fall and this spring..... Acres	006.
11. Rye harvested for grain..... Acres	011.
12. Rye used for hay, silage, pasture only, plowed under or abandoned..... Acres	031.
13a. ALL OTHER CROPS not reported above..... Acres	470.
13b. Of the above acres of small grains harvested for grain (Items 1 through 12) on how many acres were soybeans planted as a second crop..... Acres	473.
14. ACRES OF ALL LAND in the farm you are operating (include land rented from others, but exclude land rented out)..... Acres	476.
	488.
	905.
	624.
	985.

Please check here ☐ if you would like to receive a report of the results of this survey..... OFFICE USE ☐ 988

Reported by _____ Date _____

Figure 7.2 Mail survey form for obtaining data on acreage and production of grain crops (SRS, USDA).

- States with all samples laid out 1 May.

Sample fields that had abandonment or were destroyed between 1 May and 1 June survey periods must be reexamined and reported again for the 1 June survey reflecting the acreage change. The harvested acreage estimate is computed by adjusting the December Enumerative Survey Direct Expansion of the wheat acres by the ratio obtained from data reported in the Objective Yield Survey.

- States with one-half of the samples laid out 1 May and all samples accounted for 1 June.

The direct expansion of wheat acreage from the December Enumerative Survey is adjusted using the ratio obtained from data reported in the Objective Yield interviews.

Therefore, any field containing sample units that were laid out for the 1 May survey and subsequently abandoned or destroyed before the 1 June survey period must be reexamined and reported again. Tract acres for harvest will be updated to reflect changes that took place during the month. Samples laid out on 1 June will reflect proper acreage changes in the harvested to planted ratio.

- States with first samples laid out 1 June.

The December Enumerative Direct Expansion estimate of acres planted is adjusted using the Form A (planted/harvested) ratio.

c. *1 July Winter Wheat Acreage for Grain Estimate.* The current June Enumerative Direct Expansion estimate of acres for grain is the base acreage for the 1 July estimate. This acreage is adjusted as follows:

- States with all samples accounted for on 1 June.

The June Enumerative Direct Expansion estimate of acres for grain is adjusted using the ratio of number of samples remaining for harvest for the current month to the number of samples remaining for harvest the previous month.

The count of the samples referred to as "Lost after laid out samples" are taken out of the total sample count and the ratio used in making the adjustment is computed as follows:

$$F = \frac{B - (X + Y)}{B - X}$$

Where:

F = Abandonment Ratio

B = Number of B (Forms completed by enumerators to report wheat yield data from objective yield sample units) forms expected to be completed in the survey period

X = Samples intended for grain harvest but not observed

Y = "Lost Samples"

- States with additional samples to be accounted for on 1 July.

The June Enumerative Direct Expansion estimate of acres for grain is adjusted using "Lost Samples" for the samples laid out earlier and the planted/harvested ratio for samples laid out 1 July.

d. *1 July Spring Wheat Acreage for Grain Estimates.* The June Enumerative Direct Expansion estimate of acres seeded is adjusted using the planted/harvested ratio.

e. *1 August Winter Wheat Acreage for Grain Estimate.* The 1 August estimate of acres for grain is adjusted using "Lost Samples" since 1 June for samples selected from DES while samples selected from JES are adjusted by resubmitting the Form A's reflecting the acreage changes.

f. *1 August Spring Wheat Acreage for Grain Estimate.* The June Enumerative Direct Expansion estimate of acres for grain is adjusted using the Form A ratio for samples laid out on 1 August and for samples laid out on 1 July that have acreage changes. The Form A is resubmitted to reflect acreage changes.

g. *1 September and Later Wheat Acreage for Grain Estimates.* Monthly estimates on 1 September and later for both Winter and Spring Wheat are made by adjusting the JES base acreage by the same procedures followed for 1 August.

h. *Post-Harvest Interview, Form D.* The acreage reported on the Form D will be on a tract basis for all samples and will relate acreage harvested to the acreage reported for harvest in June. This ratio will then be applied to the June Enumerative base acreage and will allow the calculation of final acreage, yield and production, all derived from the June base.

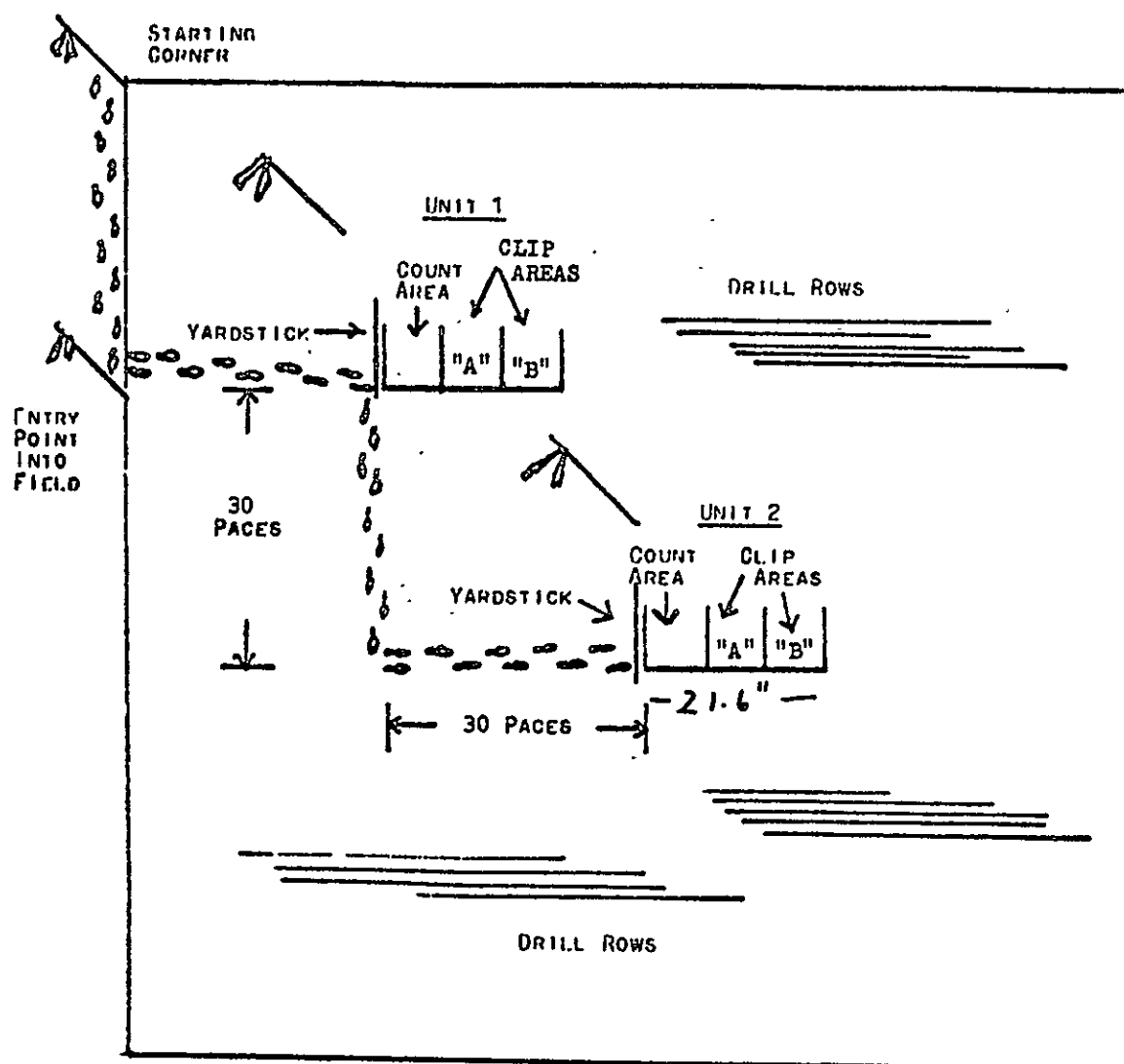
7.3 Yield Estimates

The purpose of the Objective Yield Survey for wheat is to provide a data base for establishing area and yield forecasts and estimates. During the growing season, counts and measurements are taken. These data are then used to forecast yield per acre during the growing season and to issue a final estimate after harvest. Harvesting loss per acre is estimated from gleanings obtained after selected fields have been harvested. Changes in area intended for harvest are also monitored.

7.3.1 Sample Selection. Each of the fields enumerated in either the June or December enumerative survey has a chance of being selected for the objective yield. Samples are selected with the probability of any farm being chosen proportional to its size. Observations are then made on two plots (units) chosen at random in each of the fields comprising the objective sample. A carefully designed procedure is followed in locating these sample units within each field (Figure 7.3).

7.3.2 Collection. Enumerators are given special training and provided with a manual which contains detailed instructions on sampling and recording data. They use standard forms for recording pertinent data throughout the growing season and after harvest. Briefly, clippings are taken each month and observations of particular plant characteristics (dependent on the growth stage) are recorded. In addition to the basic data, information is also collected on fertilizer use, irrigation intentions and varieties planted in sample fields.

7.3.3 Forecasts and Estimates. Counts and measurements are taken on a month to month basis and focus on the crop development stages (Table 7.1). Forecasts are made on the basis of a regression procedure using a pre-established



COUNT AREA AND CLIP AREAS LAID OUT AND MARKED

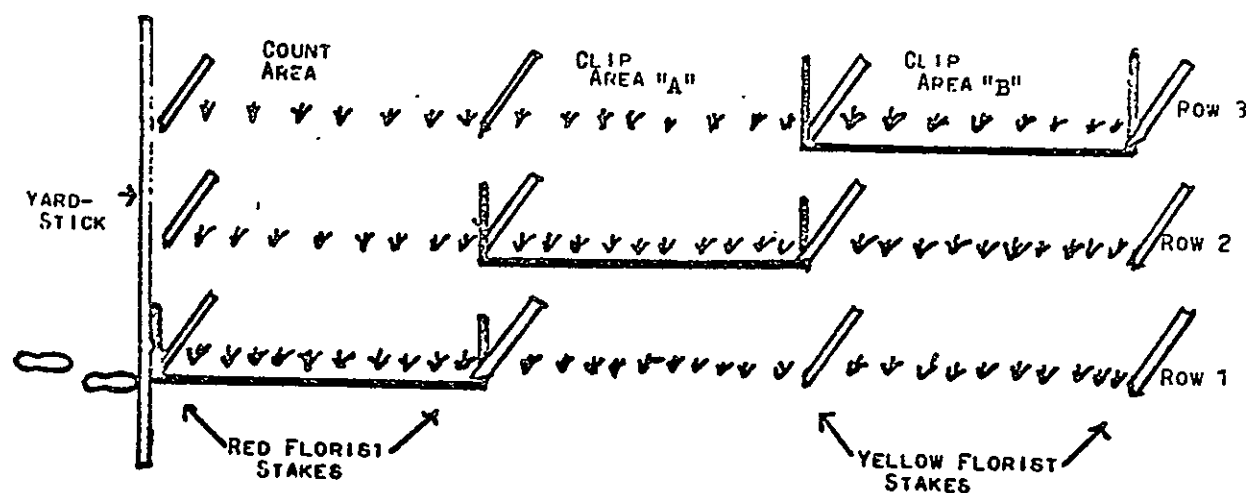


Figure 7.3 Plan for selection of count areas for Objective Yield Survey (10).

Table 7.1 Forecasting Yield Components

VARIABLES FOR FORECASTING YIELD COMPONENTS (9)

MATURITY CATEGORY	NUMBER OF HEADS		WEIGHT PER HEAD	
	Model	COUNT VARIABLE	Model	COUNT VARIABLE
1	1	Number of stalks	1	Historic average
2	1	Number of stalks	1	Historic average
	2	Stalks 10" or taller		
3	2	Stalks 10" or taller	1	Fertile spikelets per head
			2	Historic average
4	1	Emerged heads & heads in late boot	1	Grains per head
	2	Stalks 10" or taller	2	Weight per head
5	1	Emerged heads & heads in late boot	1	Grains per head
			2	Weight per head
6 & 7		Actual count of emerged heads & heads in late boot		Actual weight per head determined from laboratory work

MODELS FOR FORECASTING YIELD COMPONENTS

The forecast models are similar to the following:

$$\hat{Y} = a + b X_1$$

Where:

- \hat{Y} = Number of heads or weight per head
- a,b = Parameters derived from observed relationships from previous year(s)
- X_1 = The independent variables from current field counts, measurements,
or observations

Table 7.1 (Continued).

MODELS FOR FORECASTING YIELD COMPONENTS

The formulation for determining gross yield per acre and harvest loss for a sample are given below:

$$1. \text{ Gross yield per acre} = \left(\hat{Y}_{w1} \right) \left(\hat{Y}_{w2} \right) \left(\frac{\text{conversion factor}}{\left(\frac{10\text{-row}}{\text{space}} \right) \left(\frac{\text{width of wheat}}{\text{frame}} \right)} \right)$$

$$\hat{Y}_{w1} \text{ or } \hat{Y}_{w2} = \frac{R_2^2 \hat{Y} \text{ Model 1} + R_1^2 \hat{Y} \text{ Model 2}}{R_1^2 + R_2^2}$$

Where:

\hat{Y}_{w1} = Combined number of heads from forecast model's 1 and 2 weighted by R^2 's

\hat{Y}_{w2} = Combined weight per head from forecast model's 1 and 2 weighted by R^2 's.

\hat{Y} model 1 = Forecasted or actual* number of heads or weight per head** from model 1

\hat{Y} model 2 = Forecasted or actual* number of heads or weight per head** from model 2

R_1^2 = Multiple correlation coefficient for model 1

R_2^2 = Multiple correlation coefficient for model 2

Width of wheat frame = 21.6"

$$\text{Conversion factor} = \frac{A \cdot B \cdot C}{D \cdot E \cdot F} = \frac{(43,560)(10)(12)}{(6)(60)(453.58)} = 32.012$$

Where A is the number of square feet per acre
 B adjusts for measuring across 10 row spaces
 C converts inches to feet
 D rows counted in sample unit
 E converts pounds to bushels
 F converts grams to pounds

2. Number of heads per sample is the actual count of emerged heads plus heads in late boot for category 6 and 7 samples.

* For maturity categories 6 and 7 actual head counts and laboratory weights are used.

** For maturity categories 1 and 2 the 5 year historic average is used.

Table 7.1 (Continued).

MODELS FOR FORECASTING YIELD COMPONENTS

3. Weight per head =

$$\frac{\left(\begin{array}{c} \text{threshed weight} \\ \text{of grain} \end{array} \right) \left(\begin{array}{c} \text{threshing loss} \\ \text{adjustment} \end{array} \right) \left(\begin{array}{c} 1.0 - \text{Moisture content} \\ \text{of grain} \end{array} \right)}{(\text{Number of heads threshed})(.880)}$$

The threshing loss adjustment is the proportion of grain recovered following initial threshing. This expands the shelled grain for non-sampling errors due to threshing machine adjustments. It will vary from day to day and sample to sample depending upon moisture content, ripeness of grain and number of samples threshed.

Threshing loss adjustment =

$$\frac{\sum_{i=1}^n (\text{wt. of threshed grain}) + (\text{wt. of grain from rethreshed-chaff})}{\sum_{i=1}^n (\text{wt. of threshed grain})}$$

where n = number of lab samples threshed

$$4. \text{ Harvest loss per acre} = \frac{\left(\begin{array}{c} \text{weight of} \\ \text{threshed grain} \end{array} \right) \left(\begin{array}{c} 1.0 - \text{Moisture content} \\ \text{of grain} \end{array} \right) \left(\begin{array}{c} \text{Conversion} \\ \text{Factor} \end{array} \right)}{(.880) \left(\begin{array}{c} 10\text{-row} \\ \text{space} \end{array} \right) \left(\begin{array}{c} \text{width of} \\ \text{wheat frame} \end{array} \right)}$$

The computed gross sample yield is converted to net yield by deducting the average harvesting loss. Harvesting loss is a variable that is virtually constant except during years with extremely unfavorable weather conditions. When the post-harvest gleanings have been made, the actual harvesting loss is measured and substituted for the average. The average of the self-weighting sample net yields over a State is the State estimate of yield.

Net yield = Gross yield - Harvest loss

set of predictors such as weight, number of heads, number of kernels, and number of stalks to predict total number of heads and weight per head. When data are not available early in the growing season, the number of heads, for example, average data for the last three years are substituted. Harvest losses are estimated at the end of the growing season by measuring gleanings after harvest for a sample plot and determining net yield for each sample.

Yield is determined by the product of its two components: number of heads and weight per head. As indicated in Table 7.1, two separate regression models are used to forecast each component. The two forecasts for each component are weighted together using the squared correlation coefficient for each regression model. A detailed explanation of the yield models and survey procedures is given in Appendix 7.1.

7.4 Crop Reports

7.4.1 Crop Reporting Board. All official forecasts and estimates are made by the Crop Reporting Board (CRB) which meets monthly at the USDA in Washington, D.C. under very tight security. Security is most stringent for the speculative crops which include wheat. The Board is composed of a fixed set of USDA administrators and a rotating membership of commodity specialists and representatives of the State Statistical Offices. They issue monthly reports which cover seasonal crops.

Overall state indications which take into account the results of both the objective yield survey and mail survey results are reported directly to the CRB. The state report on wheat consists of the following information:

1) Results of nonprobability mail surveys

- number of respondents
- number of bushels expected
- regression estimate of yield

2) Objective yield results

3) Crop condition (100% = normal)

4) Precipitation

Each member of the CRB makes an independent evaluation of what the state forecast or estimate should be. State indications are interpreted using regression charts (Figure 7.4) which illustrate historically the relationship between the final state forecasts and the final estimates based on reported yield. Official state estimates are then established as well as the national total. A comparison of forecasts and final estimates for combined winter and spring wheat is given in Table 7.2.

7.4.2 Crop Reporting in Indiana. Although the general methodology for acquiring, analyzing and reporting wheat production statistics in the United States has already been described in this chapter, it seems appropriate to provide further detail at the state level. This section focuses on the procedures of the SRS used by the State Statistical Office (SSO) in Indiana. Although Indiana's main crops are corn and soybeans, the state ranks tenth in wheat production among the 50 states. Seventy-six percent of the total land area of Indiana is cultivated, and each of the 92 counties is assigned to one of nine crop reporting districts.

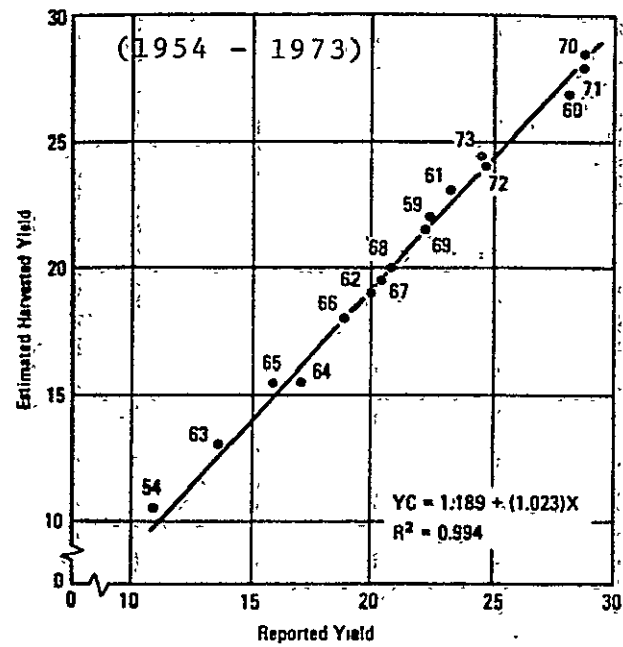


Figure 7.4. Example of a regression chart used to estimate a State's winter wheat yield in bushels per acre (7).

Table 7.2 Comparison of forecasts and final estimates in U.S. for combined winter and spring wheat (6).

Year	Area (1000 Hectares)					Yield (100Kg/Hectare)					Production (1000 Metric Tons)				
	Percentage Overestimate*				Final Estimate December	Percentage Overestimate*				Final Estimate December	Percentage Overestimate*				Final Estimate December
	JUL	AUG	SEP	OCT		JUL	AUG	SEP	OCT		JUL	AUG	SEP	OCT	
1967	1.60	1.60	1.60	1.60	23879	3.10	-2.33	-0.39	0.39	17.4	4.71	-0.85	1.23	1.93	41487
1968	14.03	1.32	1.32	1.32	22387	-0.35	1.06	0.35	0.35	19.1	1.10	2.26	1.67	1.75	42741
1969	13.97	-0.02	-0.02	-0.02	19245	-2.28	0.00	-0.33	-0.33	20.6	-2.34	-0.01	-0.13	-0.18	39705
1970	-8.40	-8.40	-8.40	-8.40	17930	-0.32	-32	-0.32	-0.32	20.9	-2.15	-1.52	-1.35	-1.33	37516
1971	0.09	-0.20	-0.20	-0.20	19609	-5.62	-2.07	-0.59	-0.30	22.7	-5.61	-2.37	-0.87	-0.73	44623
1972	1.14	1.14	1.14	1.14	19142	-0.92	-1.22	-0.31	-0.31	22.0	0.38	-0.11	0.95	0.92	42043
1973	-0.53	-0.29	-0.29	-0.29	21802	2.52	---	1.26	0.94	21.4	2.17	0.33	0.94	0.90	46577
1974	-2.71	-2.07	-2.07	-2.07	26491	10.22	4.74	1.82	1.46	18.4	7.35	2.60	-0.09	-0.71	48807
1975	-0.90	-1.14	-1.14	-1.14	28189	3.59	1.63	1.31	1.31	20.6	2.52	0.32	0.12	0.19	58074
1976	-0.86	-0.57	-0.57	-0.57	28662	-3.96	-1.65	0.33	-0.33	20.4	-4.98	-2.40	-0.39	-0.97	58444
1977	0.47	0.64	0.64	0.64	26797	0.33	0.00	-0.33	0.65	20.6	0.88	0.73	3.15	0.08	55134

*Negative value indicates underestimate

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a. *Survey Responsibilities of the Indiana SSO.* Wheat area yield and production statistics are collected under the direct supervision of the State Statistical Office (Figure 7.5). Enumerative and objective yield surveys use statistically selected national samples while mail surveys sample nonrandomly from a fixed state pool.

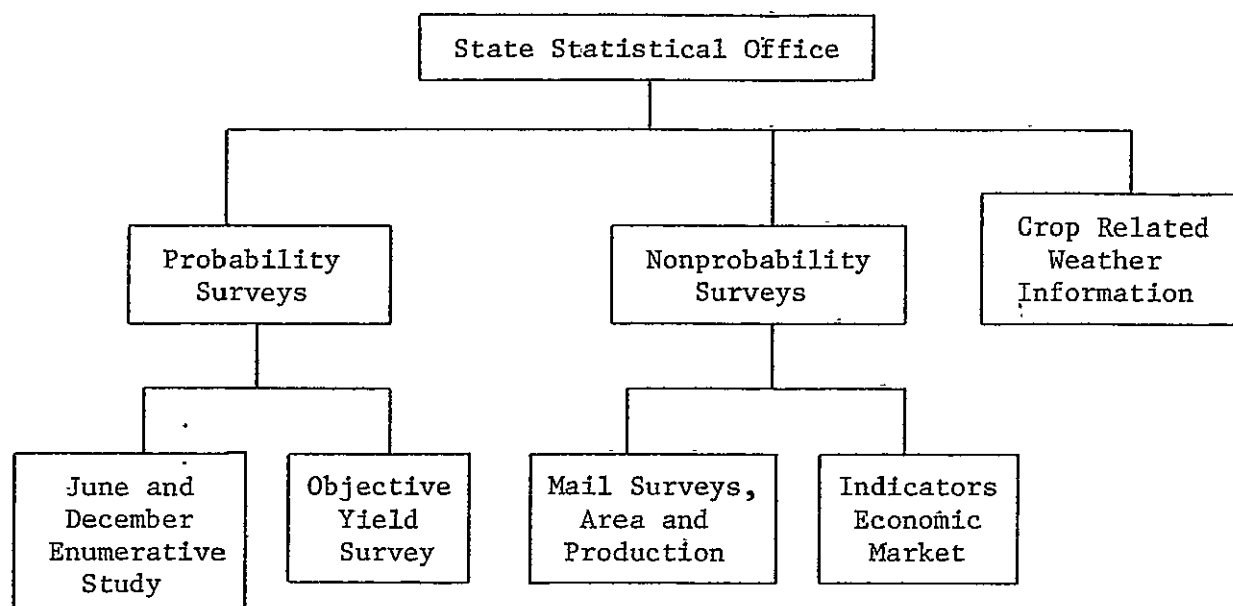


Figure 7.5 Survey tasks supervised by the State Statistical Office.

State indications from acreage and production mail surveys are reported in terms of ratios and percentages, e.g., ratio of planted area to crop land and percentage change in planted area from the previous year. Regression charts are used to evaluate these indications using reported condition or probable yield and precipitation during growing season as prediction of yield per acre. Rainfall is included so that the forecasts reflect sensitivity to both deficiencies and excesses of moisture during the growing season. For any given date on which a forecast is issued, weather conditions are assumed to be normal for the remainder of the growing season.

b. *Probability Surveys.* Two probability surveys are carried out in Indiana. In the enumerative study area samples are selected and farm operators in each sample are interviewed for information regarding area planted, crop condition, expected yield, and other pertinent data. One survey is conducted in June for the entire sample and in December on a subsample.

The December survey emphasizes acreage estimates of fall seeded crops such as winter wheat. Specifically, a stratified two-sample design is used with tracts classified in strata and a subsample chosen from selected strata. Direct expansion estimates are obtained by associating a probability of selection with each tract sampled with this probability being a product of the sampling probabilities at each stage. Sampling errors are determined from variation between segments.

The objective yield survey provides crop yield information for forecasts and estimates based directly on counts and measurements of wheat. A systematic sampling scheme is used for selection based on a geographical arrangement of tracts. Fields are selected from chosen tracts based on probabilities proportional to area. Observations are then made on two randomly selected plots (the smallest sampling unit) in each of these selected fields.

Counts and measurements are conducted on a month to month basis and focus on the crop development stages. Forecasts are made on the basis of a regression procedure using a pre-established set of predictors such as weight, moisture content, precipitation, number of heads, number of kernels, number of stalks, and height of stalks. When data are not available early in the growing season, the number of heads, for example, average data for the last three years are substituted. In states other than Indiana, separate estimates are derived for irrigated and nonirrigated fields and a weighted average is computed.

All data processing is done using the pre-programmed routines available on a computer linkup with the USDA INFONET network (Figure 7.1). Additional data on crops and livestock are obtained from mail surveys (Figure 7.6). These reports are evaluated using regression charts. Monthly reports give the official estimate set by the CRB as well as a breakdown of wheat statistics by variety, region and county. In addition, information concerning fertilizer usage is reported together with observations from grain elevator operators. A comparison between forecasts and final estimates of wheat area, yield and production of wheat in Indiana for the period 1967 through 1977 is shown in Table 7.3.

Overall state indications take into account the results of both the objective yield survey and mail survey results. The following information is reported directly to the Crop Reporting Board:

- Results of nonprobability mail survey
 - number of respondents
 - number of bushels expected
 - regression estimate of yield
- Objective yield results
- Crop condition (100% = normal)
- Precipitation

The USDA uses mail survey results to help interpret results from statistical models based on objective yield data.

Crop Reporting Board
Statistical Reporting Service
U.S. Department of Agriculture

FARM REPORT

Ind. III.

Please make corrections in name, address, and ZIP Code, if necessary.

PLEASE MAIL BY
JUNE 1, 1977

Dear Crop Reporter,

With most crops up, more interest is shown in the summary of crop conditions. This service is possible only with the help of volunteer reporters like you. Thanks.

Let us have any additional comments you want to make on this month's weather... or other factors affecting the condition of crops.

Please remember to:

1. Note the instructions.
2. Mail your report promptly in the enclosed envelope which needs no stamp.

Respectfully,

Bruce M. Graham
Bruce M. Graham
Chairman, Crop Reporting Board

P.S. Individual reports are kept confidential.

"Farm With Facts"

INSTRUCTIONS

Report the condition of crops and pastures now, as compared with the normal growth and vitality you would expect at this time, if there had been no damage from unfavorable weather, insects, pests, etc. Let 100 percent represent a normal condition for field crops or a full crop for fruits.

• Use letter F to indicate an entire failure. Enter dash (-) for the questions that do not apply to your locality. On questions relating to your operations, enter 0 when zero or none is the answer.

• In reporting grain sold and to be sold include quantities of the 1976 crop only. Report sales to date plus expected future sales from the 1976 crop. Include the landlord's share as sales if it is moved off this place. Also, include 1976 grains placed under loan or purchase agreement as sales except quantities you expect to redeem and feed.

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Please Answer These Questions For All Land You Operate		Answer here ↓
CROP PRODUCTION AND STOCKS		
Report total old-crop stocks on this farm regardless of ownership or intended use. Include all whole (not ground) grain on this farm intended for feeding for sale, and for seed as well as quantities under loan or resale programs. Exclude new crop (1977) grain and all grain you own that is stored off the farm you operate.		
CORN produced on this farm last year (1976 crop) - 70 lb. ear or 56 lb. shelled BUSHELS		011
CORN on this farm June 1, 1977 from 1976 and earlier years - 70 lb. ear or 56 lb. shelled BUSHELS		012
WHEAT produced on this farm last year (1976 crop) - 60 pound BUSHELS		031
WHEAT, old crop, on this farm June 1, 1977 from 1976 and earlier years - 60 pound BUSHELS		032
OATS produced on this farm last year (1976 crop) - 32 pound BUSHELS		091
OATS on this farm June 1, 1977 from 1976 and earlier years - 32 pound BUSHELS		092
BARLEY produced on this farm last year (1976 crop) - 48 pound BUSHELS		101
BARLEY, old crop, on this farm June 1, 1977 from 1976 and earlier years - 48 pound BUSHELS		102
RYE produced on this farm last year (1976 crop) - 56 pound BUSHELS		131
RYE, old crop, on this farm June 1, 1977 from 1976 and earlier years - 56 pound BUSHELS		132
SOYBEANS produced on this farm last year (1976 crop) - 60 pound BUSHELS		141
SOYBEANS on this farm June 1, 1977 from 1976 and earlier years - 60 pound BUSHELS		142
SORGHUM GRAIN produced on this farm last year (1976 crop) - 56 pound BUSHELS		161
SORGHUM GRAIN on this farm June 1, 1977 from 1976 and earlier years - 56 pound BUSHELS		162
CROP SALES		
CORN of 1976 crop sold and to be sold - 70 lb. ear or 56 lb. shelled BUSHELS		013
OATS of 1976 crop sold and to be sold - 32 pound BUSHELS		093
BARLEY of 1976 crop sold and to be sold - 48 pound BUSHELS		103
SORGHUM GRAIN of 1976 crop sold and to be sold - 56 pound BUSHELS		163
Please Answer These Questions For Your Locality		Answer here ↓
FIELD CROPS		
WHEAT, condition of crop to be harvested for grain - PERCENT		04
WHEAT, probable yield per acre this year in 60 pound BUSHELS		034
PASTURE condition in PERCENT		266
ALL CROP PROSPECTS for 1977, as percent of normal - PERCENT		470
FRUIT CROP		
PEACHES, condition as a percent of a full crop - PERCENT		575

Figure 7.6 State Farm Report Survey--Indiana.

Table 7.3 Comparison of forecasts and estimates of winter wheat in Indiana (6).

Year	Area (1000 Hectares)				Final Estimate December	Yield (100Kg/Hectare)				Final Estimate December	Production (1000 Metric Tons)				Final Estimate December
	Percentage Overestimate*					Percentage Overestimate*					Percentage Overestimate*				
	MAY	JUN	JUL	AUG		MAY	JUN	JUL	AUG		MAY	JUN	JUL	AUG	
1967	-8.41	-8.41	-6.27	---	529	8.11	10.81	16.22	0.00	24.9	-0.98	1.49	8.93	-6.27	1317
1968	7.10	7.10	7.10	---	410	8.57	8.57	8.57	5.71	23.5	16.28	16.28	16.28	16.28	966
1969	1.56	1.56	1.56	---	364	-2.56	2.56	2.56	0.00	26.2	-1.05	4.16	4.16	1.56	954
1970	0.13	0.13	0.13	---	313	3.90	3.90	1.30	0.00	25.9	3.76	3.76	1.17	-0.13	811
1971	-3.13	-3.13	2.18	2.18	297	-15.56	-13.33	-13.33	-2.22	30.3	-18.20	-16.05	-11.45	-0.09	900
1972	1.45	1.45	2.30	2.30	334	-8.33	-2.08	-6.25	-2.08	32.3	-7.00	-0.66	-4.09	0.17	1079
1973	-5.41	-5.41	-1.14	-1.14	284	20.00	20.00	14.29	0.00	23.5	13.51	13.51	12.99	-1.14	670
1974	0.72	0.72	-0.72	-0.72	563	25.00	25.00	2.78	0.00	24.2	25.90	25.90	2.04	-0.72	1362
1975	0.00	0.00	0.00	0.00	607	-2.33	2.33	0.00	0.00	28.9	-2.33	-2.33	0.00	0.00	1755
1976	-6.25	-6.25	-6.25	-6.25	648	16.67	11.11	8.33	0.00	24.2	9.38	4.17	1.56	-6.25	1568
1977	0.81	0.81	2.02	2.02	502	-15.56	-11.11	-6.67	-4.44	30.3	-14.87	-10.39	-4.78	-2.52	1519

*Negative value indicates underestimate

†Data not available

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7.5 Comments

The probability sampling and objective yield survey techniques used by the U.S. Department of Agriculture have been developed over a period of several decades. These techniques appear to be used quite effectively in obtaining valid crop survey data on a local and state basis. As these data are aggregated for determining national yield and production estimates, subjective adjustments are made to arrive at the final estimates.

Some of the questions left unanswered by this study concerning the methodology used in the United States are:

- What criteria are used to rationalize the subjective adjustments to determine the final national yield and production estimates?
- What are the limitations of the objective yield surveys which require subjective adjustments to obtain the periodic national yield estimates?
- Given that subjective adjustments are made in yield and production estimates, how can the stated coefficients of variation be defended statistically?

The authors were able to obtain a good overview of how the U.S. crop reporting system works. Sufficient information was available to describe in detail the methods of acquiring objective yield data. It was not possible to document in detail the methods of statistical analysis and aggregation at the state and national levels.

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APPENDIX 7.1 OBJECTIVE YIELD SURVEY FOR WHEAT (11)

To forecast yield per acre by States, a series of equations is used for forecasting the two components of yield which are weight of grain per head and number of heads for each sample. These components are combined to give a forecast of bushels per acre for each sample. A bushel of wheat for objective yield forecasts and estimates is defined to be a 60-pound bushel at 12 percent moisture. Since fields are selected with probabilities proportional to acreage, the average of these individual sample yields provides a self-weighted forecast of yield per acre for the State. The forecast equations used for a sample depend to a great extent on the maturity classification of the sample units. For this reason, it is extremely important that maturity categories be well defined and sample units properly classified.

The forecasting procedures use, in general, two models for predicting each of the yield components (head weight and number of heads). The equations for these models are developed by relating counts and measurements of plant characteristics made during the growing season to actual counts, measurements, or weights made for identical samples at harvest time. For example, the count of stalks 10 inches or taller and the number of observed heads emerged on in boot both provide independent variables for predicting the number of heads expected at harvest time for a sample in the late boot or flower maturity category.

Plant characteristics, such as the number of healthy plants, moisture content of kernels, and height of plants, have limited use for purposes of forecasting because they vary from year to year due to environmental or weather factors. On the other hand, characteristics such as total number of plants, number of spikelets and number of developing heads and their associated components give stable relations over time. It is these factors that the models utilize in the early forecasts of the biological yield. Several years of experimental work are necessary for isolating desirable and identifiable characteristics which can be used for forecasting. For reliable forecasting these characteristics must be measured for two or three years in order to develop the equations which describe the relationships between early season counts and final observed counts and measurements.

The forecasts of number of heads and head weight are made from current counts and measurements and the harvesting loss is a moving five-year average observed loss in bushels per acre.

Since more than one model may be used to forecast a component, it is necessary to weight models together in some appropriate manner to obtain a single forecast of a component. The wheat crop develops differently within geographic areas due to differences in climatic conditions, varieties, soils, and cultural practices. Consequently, no one forecasting model is superior for all wheat producing areas of the country. The multiple correlation coefficient provides a measure of the relative effectiveness of the models used in a State and is used to weight models together.

The multiple correlation coefficient is a ratio that shows what proportion of the total variation can be explained by the model and ranges between 0 and 1. A higher correlation coefficient indicates a more reliable model.

The major early season independent variable used to forecast the expected number of heads is the observed stalk count. For example, in the Corn Belt

States one head is expected for each two to three stalks observed on May 1. At this stage of development there are very few observable plant characteristics that are associated with expected weight per head. Consequently, it is necessary to rely on the historic average head weight for predicting the second component needed for forecasting yield. The observed head weight does vary somewhat by years for individual States, but is stable for groups of States.

Using an average head weight tends to stabilize early season forecasts, particularly for regions. As the crop develops toward mid-season, more plant characteristics appear that can be accurately defined, measured and related to final yield.

It is in this period of early head development that the plant enters a transition stage as it shifts from vegetative growth to a grain development period. At this point, it is possible to make the first forecast of head weight based on observable and measurable plant characteristics. Wheat heads have from 10 to 20 spikelets per head which are clearly distinguishable when the stalk reaches the boot stage. Within most of these spikelets one to three grains will form. Therefore, the number of spikelets provides the first indication of head weight. The expected head weight is predicted from this characteristic using an equation similar to the one mentioned for number of heads above.

When the wheat plant reaches the late stage of development, the maximum fruit load has been set and the physiological processes of the wheat plant are directed toward kernel development. Head counts at this stage are actually one to six percent higher than they will be at harvest time. Hence, the model uses a slight downward adjustment on the observed head count to predict the number of heads where kernels are filling and can be accurately identified and counted. The observed weight of the head and the observed number of kernels per head are used at this stage for predicting the final head weight. At this time, forecasts become even more precise since effect of unfavorable weather or environmental conditions on final biological yield is reduced considerably. Net yield, however, can still be affected by factors which influence the harvesting loss (HL).

When a field reaches the hard dough or ripe stage, the sample units are harvested. Number of heads, average grain weight per head and the moisture content of the grain are determined for each sample. The number of heads is expanded to heads per acre and grain weight per head is adjusted to a standard moisture of 12 percent. These actual yield components may be substituted in the formulation of forecast yield per acre stated earlier (less the HL term) to give the actual sample gross yield per acre.

CHAPTER 8

GLOBAL STATISTICS FOR AREA, YIELD AND PRODUCTION OF WHEAT

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CHAPTER 8

GLOBAL STATISTICS FOR AREA, YIELD AND PRODUCTION OF WHEAT

Users of global wheat statistics are largely dependent upon the data compiled and reported by the United States Department of Agriculture, the Food and Agriculture Organization and the International Wheat Council. Since each of these agencies uses common sources of data, the statistics they publish may be exactly the same. However, the yield and production statistics during some years may vary somewhat among the three agencies. It is not within the scope of this study to evaluate the methods used by these organizations and to determine the reasons for the differences in their estimates.

Although this study did not examine other methods of crop reporting in detail, it should be noted that a number of the large grain companies maintain and operate their own information systems. In general, they use published data available from USDA, FAO and IWC. However, they may have supplemental information concerning planting intentions, crop conditions, drought or other situations which is used to adjust or refine the published estimates.

Another U.S. government agency outside the USDA compiles crop production statistics. The Central Intelligence Agency (CIA) operates its own food information system.

For the purposes of this study a comparison was made of the estimates of area, yield and production reported by USDA, FAO and IWC for Argentina, Canada, India, USA, and USSR for the period 1965-1975 (Tables 8.1-8.3).

8.1 U.S. Department of Agriculture (USDA)

By law the Statistical Reporting Service (SRS) of the United States Department of Agriculture is responsible for acquiring, analyzing and reporting domestic wheat production statistics for the United States. The Foreign Agricultural Service (FAS) has the primary responsibility within USDA for compiling, evaluating and reporting crop production statistics for other countries. The Economic Research Service (ERS) analyzes a country's total agricultural production and its long range effect on the world economy. A more complete description of the USDA foreign crop reporting system appears in Appendix 8.1.

8.2 Food and Agriculture Organization (FAO)

Within the United Nations the Food and Agriculture Organization has primary responsibility for monitoring and reporting globally the food situation. The agency within FAO which is charged with the task of acquiring, analyzing and reporting crop production statistics is the Statistics Division of the Economic and Social Department. The nature of the organization dictates that FAO compile and publish statistics reported to them by member

Table 8.1 Area estimates from three different agencies of wheat in five major wheat-producing nations (1,2,5).

Country and Reporting Agency	<u>1965</u>	<u>1966</u>	<u>1967</u>	<u>1968</u>	<u>1969</u>	<u>1970</u>	<u>1971</u>	<u>1972</u>	<u>1973</u>	<u>1974</u>	<u>1975</u>
	(Thousands of Hectares)										
ARGENTINA											
USDA	4593	5214	5812	5837	5191	3701	4315	4965	3958	4233	5270
FAO	4601	5214	5812	5837	5191	3701	4315	5025	3958	4233	5339
IWC	4593	5214	5812	5837	5191	3701	4315	4965	3958	3900	5100
CANADA											
USDA	11446	12016	12190	11907	10104	5052	7854	8640	9575	8935	9479
FAO	11453	12016	12189	11907	10104	5052	7854	8640	9575	8934	9479
IWC	11445	12016	12190	11907	10104	5052	7854	8640	9430	8934	9479
INDIA											
USDA	13460	12656	13135	14998	15958	16626	18240	19139	19463	19057	18010
FAO	13422	12565	12838	14998	15958	16626	18241	19163	19464	18583	18107
IWC	13460	12656	12838	14998	15958	16626	18241	19139	19881	18583	17957
US											
USDA	20057	20181	23784	22364	19254	17630	19294	19136	21800	26547	28208
FAO	20056	20077	23614	22162	19079	17629	20507	19142	21800	26552	28188
IWC	20056	20181	23878	22364	19245	17863	19293	19135	21803	26553	28189
USSR											
USDA	70214	70012	66823	67231	66427	65230	64035	58492	63012	59684	61985
FAO	70205	69958	67026	67231	66426	65230	64035	58500	63155	59676	61985
IWC	70205	69958	67026	67230	66426	65200	64035	58500	63100	59676	61895

Table 8.2 Yield estimates from three different agencies of wheat for five major wheat-producing nations (1,2,5).

Country and Reporting Agency	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
	(Quintals Per Hectare)										
ARGENTINA											
USDA	13.50	12.00	12.60	9.80	13.50	13.30	13.20	13.90	16.60	14.10	16.30
FAO	13.21	11.98	12.60	9.83	13.52	13.29	13.16	16.12	16.57	14.10	16.03
IWC	13.50	12.00	12.60	9.80	13.50	13.30	13.20	15.90	16.50	14.90	16.80
CANADA											
USDA	15.40	18.80	13.30	14.90	18.40	17.90	18.30	16.80	16.90	14.90	18.00
FAO	15.43	18.74	13.24	14.85	18.43	17.86	18.35	16.80	16.88	14.88	18.02
IWC	15.40	18.70	13.20	14.90	18.40	17.90	18.30	16.80	16.70	14.90	18.00
INDIA											
USDA	9.20	8.20	9.00	11.00	11.70	12.10	13.10	13.80	12.70	11.40	13.40
FAO	9.13	8.24	8.87	11.03	11.69	12.09	13.07	13.82	12.71	11.72	13.38
IWC	9.10	8.20	8.90	11.00	11.70	12.10	13.10	13.80	12.50	11.70	13.50
US											
USDA	17.80	17.70	17.40	19.20	20.60	20.90	22.80	22.00	21.30	18.40	20.60
FAO	17.85	17.69	17.38	19.12	20.58	20.87	21.47	21.96	21.29	18.41	20.60
IWC	17.90	17.70	17.40	19.20	20.60	20.80	22.80	22.00	21.40	18.40	20.60
USSR											
USDA	6.70	12.20	9.60	11.40	9.40	12.70	12.80	14.70	17.40	14.00	10.70
FAO	8.50	14.37	11.55	13.89	12.03	15.29	15.42	14.67	17.38	14.06	10.67
IWC	8.50	14.40	11.50	13.90	12.00	15.30	15.40	14.70	17.40	14.10	10.70

X

Table 8.3 Production estimates from three different agencies of wheat for five major wheat-producing nations (1,2,5).

Country and Reporting Agency	<u>1965</u>	<u>1966</u>	<u>1967</u>	<u>1968</u>	<u>1969</u> (Thousands	<u>1970</u> of Metric Tons)	<u>1971</u>	<u>1972</u>	<u>1973</u>	<u>1974</u>	<u>1975</u>
ARGENTINA											
USDA	6200	6247	7320	5740	7020	4920	5680	6900	6560	5970	8570
FAO	6079	6247	7320	5740	7020	4920	5680	8100	6560	5970	8560
IWC	6200	6247	7320	5740	7020	4920	5680	7900	6560	5970	8570
CANADA											
USDA	17661	22517	16137	17686	18623	9022	14412	14514	16159	13295	17078
FAO	17674	22516	16137	17686	18623	9023	14412	14514	16159	13295	17078
IWC	17661	22516	16137	17686	18623	9022	14412	14514	16460	13295	17070
INDIA											
USDA	12290	10424	11393	16540	18652	20093	23832	26410	24735	21780	28336
FAO	12257	10424	11393	16540	18652	20093	23833	26477	24735	21778	24235
IWC	12290	10424	11393	16540	18651	20093	23833	26410	24923	21778	24235
US											
USDA	35806	35699	41433	42899	39740	36783	44029	42046	46402	48879	58078
FAO	35805	35514	41031	42365	39204	36784	44030	42043	46408	48885	58074
IWC	35805	35699	41433	42899	39704	37291	44029	42042	46577	48879	58070
USSR											
USDA	46512	84996	64000	76600	62300	82700	81900	85950	109784	83849	66224
FAO	59686	100499	77419	93393	79917	99734	98760	85800	109784	83913	66144
IWC	59600	100499	77400	93393	79917	99664	98760	85800	109700	83913	66144

governments. The methods used and accuracy of data reported may vary widely among countries.

8.3 International Wheat Council (IWC)

The International Wheat Council (IWC), with headquarters in London, administers the International Wheat Agreement (IWA). The purpose of IWA, which first became operative in August 1949, was to introduce stability into supply, demand and price of wheat entering world trade channels. The two essential elements of the Agreement are an agreed maximum-minimum price range and a system of export and import commitments by member nations.

A major and very useful function of the administrative body of the IWA is the gathering and publishing of data on world trade in wheat and wheat flour. Member countries are obligated to report all exports, imports, prices, ocean freight costs, and other marketing charges. Other data related to wheat trade are also gathered and published (3).

8.4 Comments

Although the wheat area estimates published by USDA, FAO and IWC for the five countries included in this study are essentially the same for the years 1965 to 1975, it may be of interest to note some slight differences. For example, the area estimates from the three sources are exactly the same for 1966, 1967, 1968, 1969, 1970, 1971, and 1973 for Argentina. For 1965 the USDA and IWC report the same area; FAO reports a slightly different figure. In 1974, the figures for USDA and FAO agree; IWC reported a different amount. For 1975, all three agencies reported different area estimates for Argentina, India, and USA but the same figures for Canada and USSR.

For yield and production estimates there is less agreement than for area estimates among the statistics published by the three agencies. In general, however, the differences in yield and production estimates are not significant except for the Soviet Union for the years 1965 through 1971. In this case the estimates of FAO and IWC are the same or nearly the same; the estimates published by USDA are consistently lower. For example, the production estimate for the USSR published by USDA for 1965 was only 78% of that reported by FAO. Beginning with 1972 estimates the yield and production statistics reported by all three agencies are essentially the same for the USSR. This suggests that a relationship has existed since 1971 which did not exist before in the methods used by the three agencies in reporting yield and production statistics for the Soviet Union.

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APPENDIX 8.1

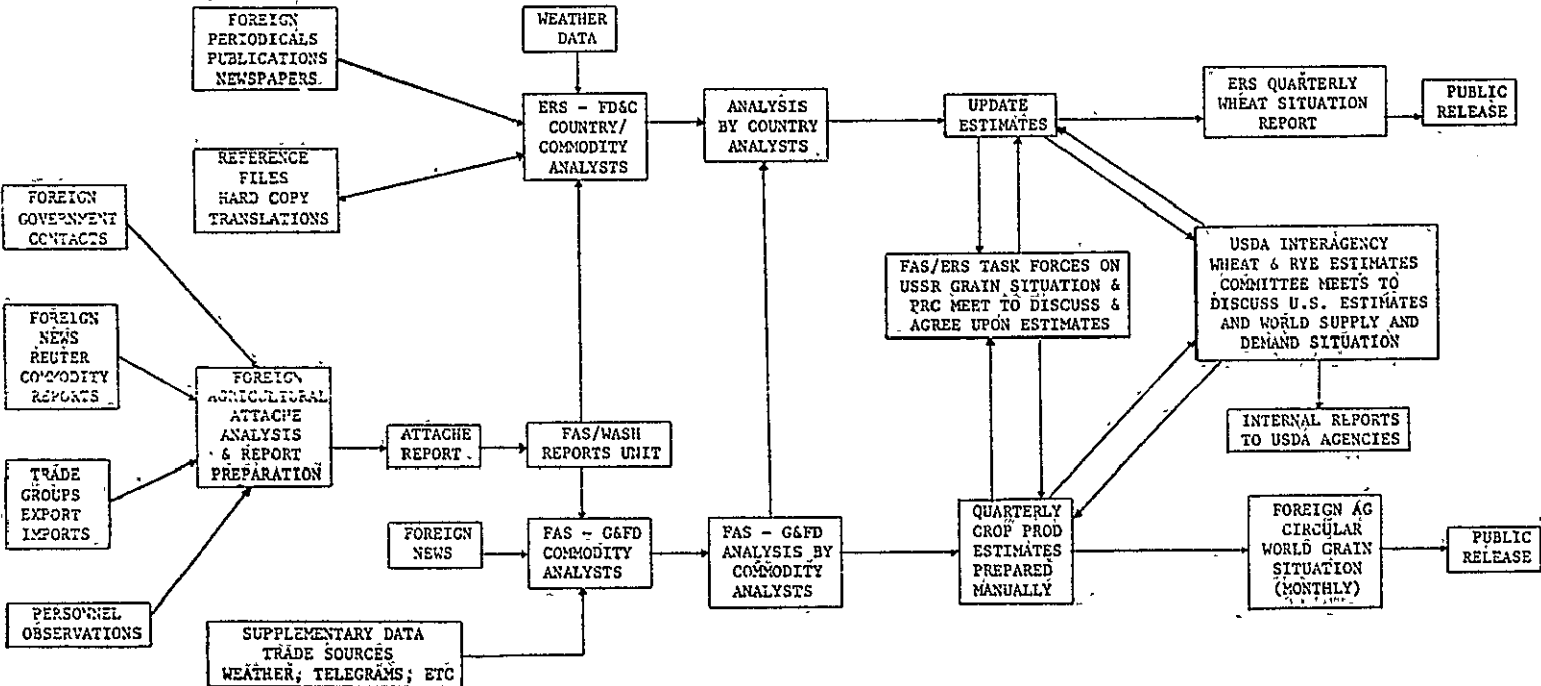
U.S.D.A. Foreign Crop Reporting System

U.S.D.A.'s main source of agricultural information for other countries is the network of agricultural attachés stationed abroad. While much of the data the attachés pass on to the Foreign Agricultural Service (FAS) and Economic Research Service (ERS) in Washington are based upon subjective observations and reports, they do provide commodity analysts in the United States with timely indications of the existing trade situation. This information system is limited by the subjective nature of reports and by lack of a centralized framework to use as a base of operations. Currently, agricultural attachés are assigned to countries with which the U.S. has import/export relations.

The Foreign Commodity Analysis Office of FAS has the primary responsibility for preparing production estimates of grains for all major grain producing countries (Figure 8.1). Sources of information include agricultural attachés, wires services, foreign newspapers and publications of foreign statistical societies and commodity services. Analysis is very often based on the attachés' reports which include personal observations on crop conditions, information from grain importers and other published reports available locally.

Commodity analysts in FAS are action-oriented and concerned with keeping abreast of the world situation. They monitor incoming information which may affect changes in the global crop situation and outlook which may influence U.S. market opportunities and policy measures. These commodity analysts are often required to respond quickly to requests from USDA concerning foreign production, existing supplies and/or disaster conditions (4).

FIGURE 8.1 USDA FOREIGN CROP ESTIMATING PROCESS (4)



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